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WEEKLY October 12 - 18, 2024

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Event

Instant Expert

Get up to speed on the weird and wonderful world of quantum mechanics in this one-day intensive workshop on 9 November at London's Congress Centre or online. Six leading quantum experts will explain this famously complex field, where nothing is as it seems until you measure it, in easy-to-understand language. This event is perfect for those curious about the quantum world, but who may not have a science background.

newscientist.com/events

Tour

The science of the Renaissance: Italy

Encounter the great minds and discoveries of the Renaissance, from Filippo Brunelleschi and Sandro Botticelli to polymaths like Leonardo da Vinci and Galileo Galilei. Join art historian Jeremy Boudreau as you explore the beautiful cities of Florence, Pisa and Bologna. This six-day tour begins on 4 November and costs £2479.

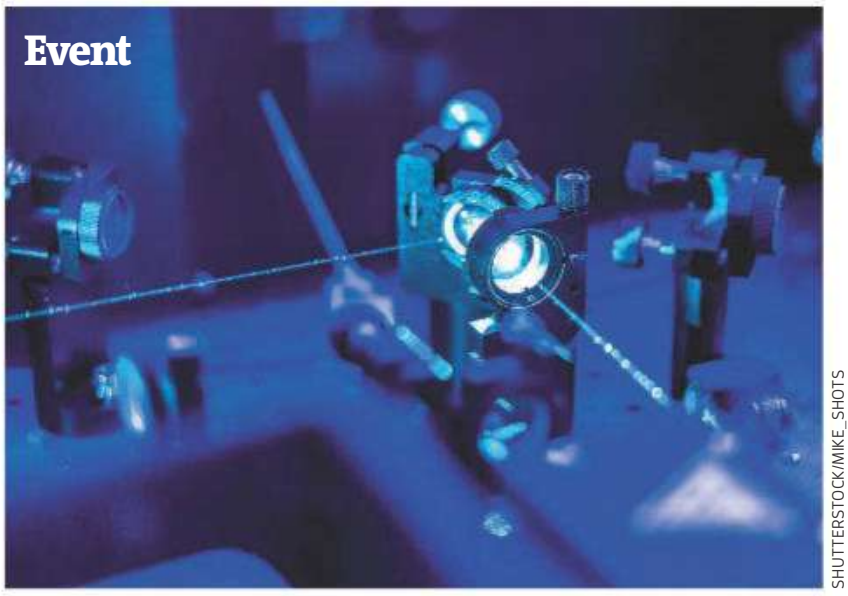
newscientist.com/tours

Podcast

Weekly

The team discuss the moving story of the death of an ancient human 17,000 years ago, and hear why we are in a golden era of exoplanetary science. They also learn about the first drone-versus-drone war, under way in Ukraine, and a study suggesting that coral reefs might be able to hang on a bit longer in the face of rapid climate change.

newscientist.com/nspod



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Guiding light Peeling back the weirdness of the quantum realm

SHUTTERSTOCK/CHERYL MINTON

Oranges and lemons Find out how we came to love citrus fruits

Video

Riding the zeitgeist

The New Scientist Book Club has been reading the late Octavia E. Butler's dystopian novel *Parable of the Sower*, which opens in a world ravaged by climate change and income inequality. Health reporter Grace Wade caught up with the writer's friend and fellow sci-fi author Nisi Shawl to discuss how Butler came to write such a prescient novel.

youtube.com/newscientist

Newsletter

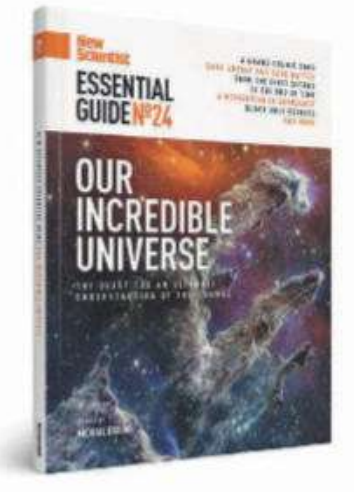
Our Human Story

One of the most important factors in human evolution is our relationship with food and how this has changed over millennia. Michael Marshall delves into how citrus fruits – which include oranges, limes and kumquats – were first domesticated and which hominins started eating them.

newscientist.com/our-human-story

Podcast

"Corals may be more capable of adapting to hotter and more acidic oceans than we thought"



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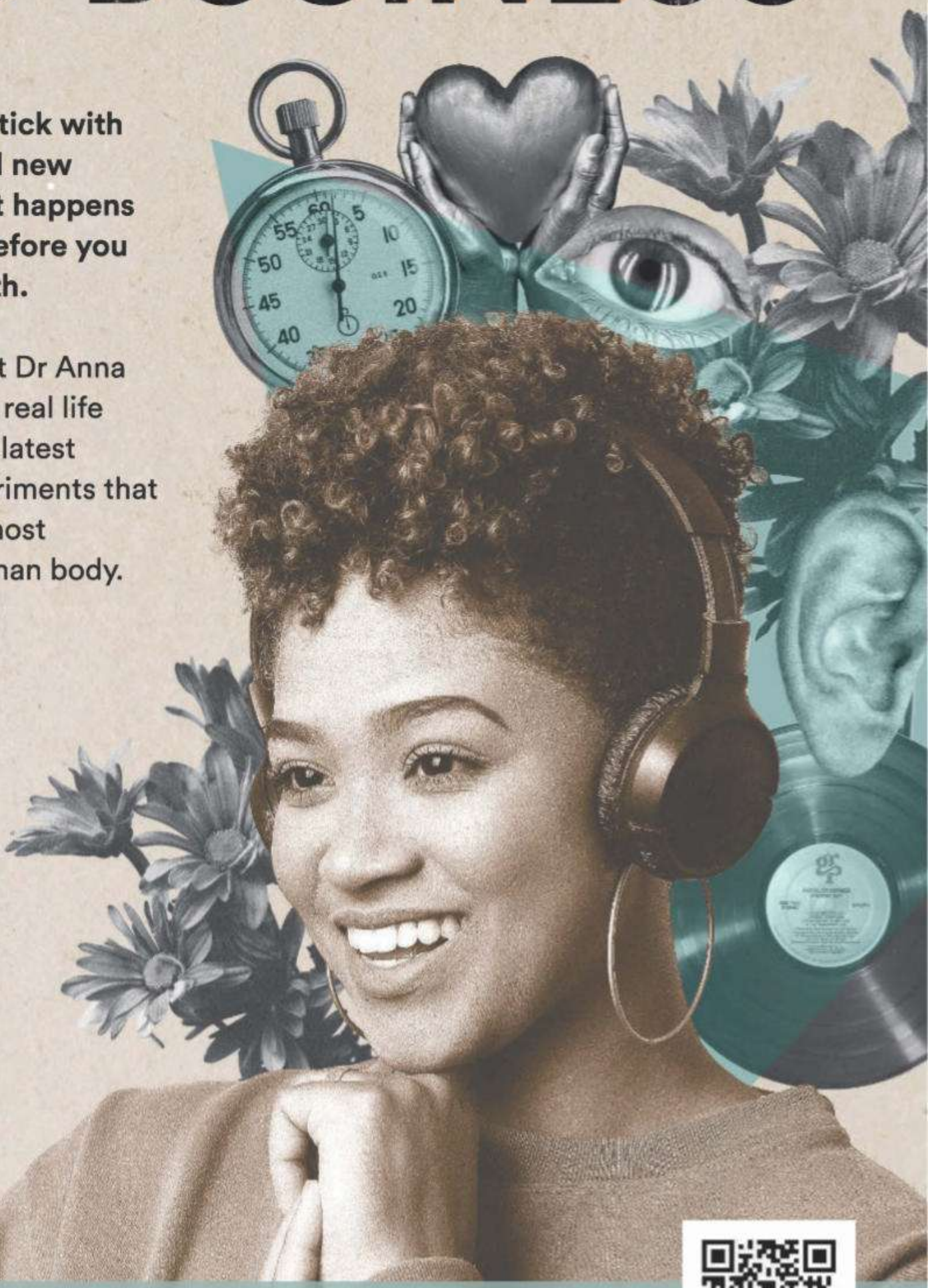

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Discovery Tours

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Arctic expedition cruise with Richard Dawkins, Svalbard, Norway

22 June 2025 | 12 days

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- Fascinating talks from evolutionary biologist and author Richard Dawkins.
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The great monarch butterfly migration: Mexico

14 January 2025 | 6 days

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- Discover the remote fir forests of Mexico's Central Highlands, where millions of monarchs roost and breed each winter.
- Accompanied by expert guides, who will delve deep into the science of this natural phenomenon walking seminars and fireside chats.
- Explore traditional Mexican mountain villages and visit a local market.
- A maximum group size of 16 people to reduce the ecological impact and to allow for a wonderous experience with the butterflies.
- "When you stand in a monarch sanctuary, your soul is shaken, and your life is changed."

Total solar eclipse 2026: North-central Spain

10 August 2026 – 5 days

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Give yourself a break

The relentless push for productivity misunderstands how the brain works

IS THERE anything more tedious than the endless drive to make every waking moment more productive? "If I can save ten seconds on a process that happens ten times per day, that's a minute and 40 seconds saved per day," a productivity guru recently advised in *Time* magazine, to take just one example. "Over the course of a year, that's ten hours saved."

If that sounds exhausting, the good news is that there are many reasons to avoid putting ourselves under this kind of relentless pressure – not least the latest neuroscience on how the brain regulates focus, as we explore on page 32.

It has to do with a tiny bundle of blue-tinged neurons in the brainstem called the locus coeruleus. According to new research, this structure acts like a gear lever that sets the pace of our brain's processing. In Gear 1, the mind can wander freely; in Gear 2, we are highly engaged and attentive; and in Gear 3, we are hyperalert and quick to respond to a crisis.

What various experiments have now shown is that moderate locus coeruleus activity – Gear 2 – is the optimum state for many types of cognitive activity. It increases our concentration, while also allowing for the kind of thinking necessary for problem-solving. Gear 3 may be useful when we are facing an emergency, but it reduces our capacity to think analytically or creatively.

"It may, in fact, be foolish to insist on driving the engine of thought at ever greater speeds"

Crucially, it turns out that the locus coeruleus can easily be tipped into Gear 3 whenever we are under pressure. If we are constantly pushing ourselves to achieve more and more in a limited amount of time, we may find ourselves stuck in this overwhelming and exhausting brain state, which will only reduce the quality of our output in the long term.

With that in mind, it may, in fact, be foolish to insist on driving the engine of thought at ever greater speeds all the time. What is too often overlooked is the need to give your brain plenty of opportunity to return to a lower gear. For high-quality thinking, contrary to much of the productivity advice, downtime may be just as productive as uptime. ▮

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© 2024 New Scientist Ltd, England.
New Scientist ISSN 0262 4079 is published weekly except for the last week in December by New Scientist Ltd, England. New Scientist (Online) ISSN 2059 5387. New Scientist Limited, US 600 Fifth Avenue, 7th Floor, NY 10020

Periodicals postage paid at New York, NY and other mailing offices. Postmaster: Send address changes to New Scientist, PO Box 3806, Chesterfield, MO 63006-9953, USA. Registered at the Post Office as a newspaper and printed in USA by Quad, 555 South 108th Street, West Allis, WI 53214-1145

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NewScientist

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Leah Crane
Space and physics reporter

News

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Parkrun events could increase your life satisfaction p19

Space

Hera mission heads to smash-up site

This fiery scene is the Hera mission launching towards space. The European Space Agency mission took off from Cape Canaveral, Florida, on 7 October at 10.52am local time. The spacecraft is heading to Dimorphos, an asteroid that NASA's DART mission knocked off course in September 2022. Hera's job is to gather more data about Dimorphos so we can understand how impacts could deflect bodies on a collision course with Earth.

CHARLES BRIGGS/ZUMA PRESS WIRE/SHUTTERSTOCK

Environment

Earth's 'vital signs' spark alarm

Key climate indicators from ice loss to greenhouse gas emissions have deteriorated in the past year in what may be a new phase of the climate crisis. **James Dinneen** reports

A GROWING number of the planet's "vital signs" that reflect the state of the climate and the wider environment are worryingly bad, according to a stark report.

"We are on the brink of an irreversible climate disaster," write William Ripple at Oregon State University and his colleagues. "This is a global emergency beyond any doubt. Much of the very fabric of life on Earth is imperilled."

Their assessment comes in the fifth annual *State of the Climate* report led by Ripple in an effort to present a clear warning of what

"This is a global emergency beyond any doubt. Much of the very fabric of life on Earth is imperilled"

the researchers say is a crisis given the extremes measured across key indicators, from greenhouse gas levels to tree cover loss.

"The climate crisis isn't a distant threat, it's a here-and-now crisis," says Michael Mann at the University of Pennsylvania, one of several well-known co-authors of the report, which also includes historian Naomi Oreskes, earth scientist Tim Lenton and oceanographer Stefan Rahmstorf.

The researchers assessed 35 "planetary vital signs", including the amount of heat in the oceans and the thickness of glaciers. The vital signs also include measures of the human factors driving many of those changes, such as meat production per capita and subsidies for fossil fuels.

Of those 35 metrics, the report finds 25 of them have reached record levels this year, most of them breaking records set in 2023. The human population rose to 8.12 billion people earlier this year, while the ruminant livestock population – a major source of methane – reached 4.22 billion animals. Greenhouse gas emissions this year have surpassed the equivalent of 40.4 billion tonnes of carbon dioxide, driving atmospheric levels of CO_2, methane and nitrous oxide – a powerful greenhouse gas emitted from soil – to new highs.

The impacts of climate change have also reached record levels. There is more heat in the oceans and seawater is more acidic, while sea level continues to rise. Record amounts of mass were lost from Greenland's ice sheet. Heat-related mortality in the US has also increased. It now stands at 0.62 per 100,000 person-years, a more than 30 per cent rise over 2023.

"We have now brought the planet into climatic conditions never witnessed by us or our prehistoric relatives within our genus, *Homo*," the researchers write (*BioScience*, doi.org/nk8p).

Five of the indicators didn't set records last year, but did in 2024. That includes record consumption of coal and oil. The Antarctic ice sheet lost more mass than at any point over the past 22 years of records. A record 11.9 million hectares of forest burned. And global average temperatures rose further above average than at any point in at least the past 145 years.

"It is staggering that, in a world where billions of people

JOSH EDELSON/AFP VIA GETTY IMAGES

Global tree cover loss resulting from fires, such as this one in California, is higher than ever

are already suffering from the impacts of climate change, fossil fuel emissions and deforestation rates are not slowing, but they are actually increasing," says Thomas Crowther, an ecologist at ETH Zurich in Switzerland and a co-author of the report.

Some of the indicators set records in the right direction in terms of mitigating climate change. For instance, solar and wind energy consumption reached record highs, and in the world of finance there was a record level of divestment from fossil fuels.

The proportion of emissions covered by carbon pricing also rose to record levels this year, and the rate of deforestation in Brazil saw a decline.

But the researchers argue this is far from sufficient. "Tragically, we are failing to avoid serious impacts, and we can now only hope to limit the extent of the damage," they write.

Such direct language is unusual for a scientific report. But the authors argue this is justified, a sentiment in line with a statement published by Ripple and his colleagues in 2020 – and now signed by more than 15,000 researchers – that said scientists have a moral obligation to warn people of the dangers of climate change.

According to the new report, "with the increasingly undeniable effects of climate change, a dire assessment is an honest assessment". ▮

Six climate indicators that set records in the past year

Global population	**8.12 billion people**
Greenhouse gas emissions	40.4 gigatonnes of CO_2 equivalent
Surface air temperature anomaly (change)	**+1.28°C**
Sea level change relative to 20-year mean	+63.8 millimetres
Greenland ice mass loss	**5470 gigatonnes**
Global tree cover loss due to fires	11.9 million hectares

Source: BioScience, DOI: 10.1093/biosci/biae087

Cosmology

Space may be filled with more antimatter than we can explain

Karmela Padavic-Callaghan

THE neighbourhood around the International Space Station (ISS) seems to contain unexpected quantities of antimatter – and it may be down to mysterious dark matter particles.

"This is weird, and the mechanism that is producing this amount of antimatter should be something exotic," says Pedro De La Torre Luque at the Autonomous University of Madrid in Spain. He and his colleagues found hints of this by analysing 15 years of data from the Alpha Magnetic Spectrometer (AMS-02) detector on the ISS.

It isn't unusual to spot antimatter particles, which have the opposite electric charge to their matter counterparts, in space. That is because it is filled with energetic particles, called cosmic rays, that create antimatter when they collide with other particles.

However, De La Torre Luque says AMS-02, which records cosmic ray signals, detected surprisingly large quantities of antimatter, including unusual forms such as heavy antimatter versions of helium nuclei – antihelium. This would suggest an origin beyond cosmic ray collisions.

To investigate, the team turned to computer simulations of unusual space-borne processes that can produce antimatter, including those involving dark matter. Dark matter is thought to make up about 27 per cent of the universe, but we know very little about its properties.

The researchers focused on hypothetical particles known as weakly interacting massive particles (WIMPs), which were conjectured in the 1980s to make up dark matter, but have never been spotted. They found that when WIMPs, should they exist, collide, they would produce antimatter particles in amounts that would match AMS-02's observations. But even that can't explain everything (*Journal of Cosmology and Astroparticle Physics*, doi.org/nk8n).

"Normal WIMPs cannot explain the amount of antihelium detected. So, it should be something much more exotic. It could [still] be dark matter, but with some additional ingredients," says De La Torre Luque.

"This is weird, and the mechanism producing this amount of antimatter should be exotic"

New models – of how particles like WIMPs could interact in novel ways, and of how they may be distributed – could clarify whether AMS-02 has detected the aftermath of their collisions.

Mattia Di Mauro at the National Institute of Nuclear Physics in Italy says it should be possible to detect signatures of dark matter particle collisions with devices like AMS-02, yet uncertainties in theoretical models and detector readings still lead to ambiguity when it comes to interpreting results. He says there is a lot that we don't know about modelling and simulating dark matter.

"We are just opening the door to understanding cosmic antinuclei and are at the beginning of a new era," says Philip von Doetinchem at the University of Hawai'i at Manoa. "More measurements in space and on the ground are crucial for pushing forward."

AMS-02 will continue collecting data until the ISS is decommissioned in 2030. A high-altitude balloon experiment will soon launch carrying a detector for antiparticles. ▮

Biology

How fish can regenerate their injured fins

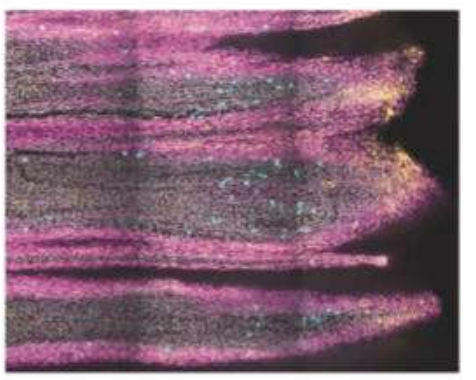
SOME fish can regrow their tails after an injury and we now have a better understanding of how they do so, which could inch us closer to regenerative medicine in people.

"Humans have all the components to regenerate, but we don't do it," says Augusto Ortega Granillo at the Stowers Institute for Medical Research in Missouri. "If we can solve this puzzle, we will have access to regeneration in humans."

To investigate this phenomenon, Granillo and his colleagues sliced off the end of the tail fins of African turquoise killifish (*Nothobranchius furzeri*).

After the injury, in each fish, cells at the tip of all its fins activated genes in charge of regeneration. The cells in the healthy fins quickly settled down again, but those in the damaged tail fin kept their regeneration genes activated.

These genes sent signals to progenitor cells, which are located in the tissues left in the tail fin, such as muscles. The cells then migrated to the injury and reproduced to make what was needed.



L: JILL TOYOSHIBA; R: GRANILLO ET AL. (2024)

African turquoise killifish (far left) can regrow fins. The near-left image shows regenerating tissue, with dividing cells (cyan) and activated skin cells (yellow) near the fin tip

While this migration was happening, skin cells were already growing and wrapping around the injury to protect the wound. These cells remade the extracellular matrix, the layer of proteins and sugar that separates the skin from the underlying tissue.

The extracellular matrix was then used like a noticeboard on which the immune system could signal to cells, says Granillo. The signals dictated how many progenitor cells were needed and where they should come from. What's more, they also seemed to tell the cells how long they needed to stick around for.

Regeneration is usually faster when more tissue is missing. But when the team edited out *sqstm1*, a gene thought to tell progenitor cells how quickly to repair damage, tissue grew back fast even with minor damage (*iScience*, doi.org/nkwv). This suggests the regeneration process triggers fast repair, but if the body recognises that the damage is minor, *sqstm1* hits the brakes. ▮

Sofia Quaglia

Health

A fall from on high

MDMA-assisted therapy was hailed as a breakthrough for mental health, but it was ultimately denied US approval. **Grace Wade** looks into what went wrong

"The future is psychedelic," declared Rick Doblin, founder of biotechnology firm Lykos Therapeutics, at a conference on psychedelic drugs last year. Several studies, many funded by Lykos, had provided tantalising signs that MDMA paired with talk therapy could dramatically reduce symptoms of post-traumatic stress disorder (PTSD).

Doblin was one of many advocates touting the drug as key to revolutionising mental healthcare. But this August, the US Food and Drug Administration (FDA) declined to approve MDMA-assisted therapy.

Some concerns are to do with the trials' methodology, which an FDA advisory committee considered to have undermined the reliability of results. The drug and associated therapy have been approved for use in some countries. Still, psychedelics are inherently difficult to study – leaving some to wonder whether we can ever build robust enough clinical trials to see them widely approved for use. Other criticisms, meanwhile, are to do with potential ethical misconduct in Lykos's trials.

MDMA has a long history (see "From party drug to psychedelic therapy", right) and in trials in the 1980s, its therapeutic benefits showed promise. Unlike other psychedelics, such as LSD and psilocybin, MDMA rarely produces vivid hallucinations. It fosters feelings of euphoria, openness and connection, which is why it was thought to have potential in combination with talk therapy. "The interaction with the therapist is, if anything, increased under the influence of MDMA," says Guy Goodwin at Compass Pathways, a UK biotechnology company.

But when the substance was outlawed in the US in 1985, research was severely restricted. By 2004, the FDA had approved a small clinical trial of MDMA-assisted therapy for PTSD in 20 participants. It found that 83 per cent of those treated with MDMA and psychotherapy no longer met the criteria for PTSD two months later compared with 25 per cent of those given a placebo and psychotherapy.

SHUTTERSTOCK/COUPERFIELD

MDMA, also known as ecstasy or molly, induces feelings of euphoria

Additional trials showed similar results, prompting the FDA to grant Lykos Therapeutics – a spin-off company of the Multidisciplinary Association for Psychedelic Studies (MAPS) – breakthrough designation for MDMA-assisted therapy in 2017. This meant the agency believed MDMA had significant potential for treating PTSD, a condition for which only two FDA-approved medications are available, both of which lead to remission in just 20 to 30 per cent of cases.

At first, the Lykos trials showed real promise. Results from 2021 found that MDMA in combination with talk therapy led to remission of PTSD symptoms for a third of participants. A phase III trial from last year showed the same for 46 per cent of participants. The seemingly remarkable results left many psychedelic proponents feeling all but certain that the FDA would greenlight MDMA-assisted therapy.

46%

of participants saw remission of PTSD in an MDMA-therapy trial

20-30%

of PTSD cases resolve using currently approved drugs

However, in August, those hopes were dashed. While the FDA declined to comment on the rationale behind the decision, a briefing document reviewed by the panel sheds light on the agency's apprehensions.

Troubling trials

One of the primary concerns was related to blinding, a technique that prevents doctors and participants from knowing if someone received a treatment or a placebo. If a participant believes they received a treatment, they can anticipate their symptoms lessening, which often leads to improvement – even if the intervention was ineffective. This is called the placebo effect.

In trials of MDMA-assisted therapy, roughly 90 per cent of those assigned to the drug and 75 per cent of those receiving just talk therapy could accurately guess which group they were in. As such, those who believed they received MDMA may have expected, and thus experienced, improved symptoms. "It is really important to conduct blinded studies, but it's difficult – and some say even impossible – to completely effectively blind psychedelic studies," says David Yaden at Johns Hopkins University in Maryland.

"While there is no perfect solution to functional unblinding, we took many steps to minimise its potential impact, including the use of independent, blinded, third-party clinician raters to assess outcomes," said Lykos in a statement in June.

The difficulty with blinding doesn't mean psychedelic therapies are doomed. For one, the FDA has approved treatments without effective blinding. There are also other, albeit imperfect, placebos, says Yaden. These could

New Scientist Live

The balanced brain

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include other PTSD treatments, or psychoactive substances like THC, that aren't expected to have therapeutic effects.

Compass Pathways is taking another approach. In its phase III trials investigating high-dose psilocybin for treatment-resistant depression, the company is using a lower dose of the psychedelic as a placebo, says Goodwin. The hope is this will improve blinding and reduce bias, he says.

There were also concerns about the talk therapy component. Some advisory committee members struggled to disentangle the extent to which it contributed to outcomes, and whether MDMA could suffice on its own. Yet Lykos is ardent that talk therapy and MDMA go hand in hand. The firm says the drug helps participants address trauma in therapy.

But because all of the trials included talk therapy and didn't investigate the standalone effect of MDMA, the FDA – which doesn't regulate talk therapy – struggled to identify MDMA's contribution.

To complicate matters, the FDA's briefing document states that Lykos doesn't provide rigorous guidance for how therapists should conduct talk therapy in concert with MDMA treatment. "It was so free-form that their manual could be interpreted in almost any way you chose," says Goodwin.

This could have muddied trial results. However, Lykos said in a statement: "Significant steps were taken to ensure standardisation and consistency in the psychological intervention across therapists, sites and treatment groups, and thus allowed for valid comparison between [MDMA] and placebo groups." Still, Lykos could have an MDMA-only group in future trials or use a standardised model of talk therapy to assuage the FDA's concerns.

The FDA's other major worries were related to MDMA's safety. Past research has suggested it can raise the risk of heart conditions and impair liver function. Yet according to the FDA, Lykos submitted incomplete data on cardiac safety and didn't monitor participants' liver function, despite acknowledging liver toxicity was a potential concern. The company also didn't collect data on the potential for participants to misuse MDMA, even though the FDA advised it to do so.

There have been allegations of research misconduct, including alleged lack of reporting of worsening suicidal ideation for some patients in the weeks after taking the drug. These adverse effects weren't published in study results, but a Lykos spokesperson told *New Scientist* that these were "unsubstantiated claims". In a June statement to *Medscape Medical News*, Lykos asserted: "All adverse events and serious adverse events were reported to the FDA."

A participant from Lykos's phase II trial alleges she was sexually assaulted by her therapist during the study. The company didn't include phase II trial results in its FDA application, and the scientific journal where they were published has retracted them due to unethical conduct.

"This was a terrible and harmful instance of malpractice that caused profound suffering to a participant," said Lykos in a statement, noting it reported the violation to appropriate agencies and has cut ties with the therapist. "Since then, we carefully developed and implemented new policies and practices aimed to prevent, detect, investigate, encourage reporting of, and thoroughly respond to potential instances of misconduct or unethical behaviour."

In addition, almost 40 per cent of participants in the phase III trials reported previously using MDMA recreationally. This could obscure safety data: if people with previous use are open to using a drug again, they may not have experienced negative side effects and may be less likely to do so again. The FDA also found that some participants used other therapeutic interventions during the follow-up period six months to two years after treatment, obscuring data that otherwise suggested MDMA-assisted therapy had lasting effects on PTSD symptoms.

The FDA requested that Lykos conduct an additional phase III trial, though this will take several years, the spokesperson said. If the agency had better evidence for the effectiveness of the drug, we may have seen a very different decision. But instead, a potentially groundbreaking treatment has been put on the back burner. ▮

MDMA is combined with talk therapy to treat post-traumatic stress disorder

NEW YORK TIMES/REDUX/EYEVINE

From party drug to psychedelic therapy

1912 MDMA, named for its chemical formula 3,4-methylene-dioxymethamphetamine, is first developed by pharmaceutical company Merck.

1960s and 1970s Psychologists explore using psychedelics, including LSD and MDMA, as enhancements to therapy.

1980s Recreational use of MDMA takes off at clubs and raves in the US.

1985 The US government outlaws MDMA, citing its high abuse potential.

2004 The US Food and Drug Administration (FDA) approves the first clinical trial of MDMA-assisted therapy for PTSD.

2017 Based on early evidence, the FDA grants Lykos Therapeutics breakthrough designation to test MDMA-assisted therapy. This expedites the development and review of new therapies.

2023 Australia approves MDMA-assisted therapy for PTSD.

2024 Advisory panel recommends that the Netherlands approve MDMA therapy.

Health

Cannabis extract may work as anti-mosquito pesticide

Rohini Subrahmanyam

THERE may be a new way to kill mosquitoes: the insects die when they are exposed to cannabidiol (CBD), a chemical produced by cannabis plants. Even better, CBD is lethal even in mosquitoes that are resistant to standard pesticides.

Mosquitoes can carry pathogens responsible for diseases including malaria and dengue fever. Some are also becoming resistant to the insecticides used against them.

But Erick Martinez Rodriguez and Peter Piermarini at Ohio State University and their colleagues have found that the larvae of *Aedes aegypti* mosquitoes, which can carry yellow fever, die within two days of consuming an extract taken from the leaves of hemp, a type of cannabis. Even mosquitoes resistant to commercial insecticides succumbed to the hemp extract.

The researchers found that CBD was highly abundant in the leaf extracts, so they tested the effects of pure CBD against the larvae. It had a similar effect as the hemp extracts, leading the team to conclude that CBD is toxic to the larvae (*Insects*, doi.org/nkw3).

"One of the advantages of hemp is that it is an emerging crop and in high demand," says Martinez Rodriguez. "There will likely be an abundance of raw material to generate a hemp-based insecticide."

Rodriguez and Piermarini now want to explore whether CBD kills adult female mosquitoes as well, since it is adult females that bite people and transmit disease.

It is unclear, though, whether CBD kills mosquitoes exclusively or is lethal to insects more broadly. Rameshwar Rattan at Mahindra Summit Agriscience in India suspects it may not have broad effects because it is a plant-derived chemical. "Biological [compounds] come from nature, so they should generally not harm it," he says. ▮

Marine biology

Two injured comb jellies can merge to form one individual

Claire Ainsworth

SHIMMERING sea creatures called comb jellies have an astonishing ability: if injured, two can merge into one, without showing the kind of tissue rejection seen in other animals. What's more, the two animals' nervous systems integrate and their digestive tracts fuse to share food.

The discovery could help us explore how immune systems evolved the ability to distinguish an organism's own tissues from those of another, and develop insights into the evolution of nervous systems.

Despite their name, comb jellies, or ctenophores, aren't jellyfish – their bodies differ fundamentally. They are the earliest creatures still living to branch from the common ancestor of all animals. They have a unique nervous system consisting of nerve cells that merge together to form a continuous net-like structure, rather than having individual nerve cells like other animals.

Kei Jokura at the University of Exeter, UK, was studying a ctenophore species known as *Mnemiopsis leidyi* when he noticed an unusually large individual. It had two rear ends and two sensory features known as apical organs, as if two individuals had joined together.

> **"It could mean that the very first animals were more plastic, were more able to adapt"**

To test this idea, he and his colleagues cut off parts of individuals collected from different locations and placed them together in pairs. In nine out of 10 cases, the two bodies fused seamlessly into one within a few hours. "I was very surprised," says Jokura.

Unlike the norm in most other animals, one body didn't reject the foreign tissue of the other, suggesting that the ctenophore immune system lacks the ability to distinguish between "self" and "non-self", known as allorecognition.

When the team gently prodded one lobe, the whole fused body reacted as one, contracting its muscles in a synchronised way, suggesting that the two nervous systems had also fully merged. The digestive tract had fused too: when the team fed just one of the mouths, the food made its way into the joined tract (*Current Biology*, DOI: 10.1016/j.cub.2024.07.084).

"It's a fascinating first finding," says Pawel Burkhardt at the University of Bergen in Norway. "It opens many new questions you can study." These could include when animals evolved allorecognition and how nerve nets form and process information.

These aren't the only questions ctenophores could help answer. Burkhardt and his team recently found that when injured, *M. leidyi* individuals can reverse their development, reverting from an adult stage to a larval-like stage, and then back again. Until now, the only known examples of animals with similar abilities have been a handful of jellyfish species such as the so-called immortal jellyfish (*Turritopsis dohrnii*) and a species of tapeworm.

That ctenophores can also do this suggests it might have been a feature of the last common ancestor of all animals, and may be more widespread than we thought. "It could mean that the very first animals were more plastic, were more able to adapt," says Burkhardt.

These enigmatic animals could be key to us understanding a swathe of fundamental biological processes relating to tissue rejection, regeneration and ageing. ▮

Muscle contractions are coordinated in this comb jelly, a fusion of two individuals

MARIANA RODRIGUEZ-SANTIAGO

Space

Astronauts could eat asteroids

Milkshake-like drink can be made from bacteria that consume carbon-containing compounds

Alex Wilkins

FUTURE astronauts could enjoy a nutritionally perfect diet made from bacteria reared on ground-up asteroids, to produce a kind of milkshake or yogurt.

While astronauts on the International Space Station have experimented with growing salad leaves, the vast majority of food consumed in space is transported from Earth. This would be impossible for more distant, longer-lasting missions, so Joshua Pearce at Western University in Ontario, Canada, and his colleagues decided to investigate using bacteria to convert carbon-containing compounds from asteroids into edible food.

They have yet to carry out this process using real asteroids, but Pearce and his team have performed similar experiments using bacteria to break down plastic from leftover army ration packets. To do this, they heated the plastic in the absence of oxygen, a process called pyrolysis, then fed this to a mixture of bacteria that eat carbon.

"When you look at the pyrolysis breakdown products that we know that bacteria can eat, and then what's in asteroids, it matches up pretty reasonably," says Pearce. "So I think this can actually work."

STOCKFOOD/ADDICTIVE STOCK

A drink made from asteroid dust wouldn't taste quite as good as real caramel milkshake

The collective bacteria end up looking "something like a caramel milkshake", says Pearce, and the team has also experimented with drying out this substance to produce something like yogurt or even a powder (*International Journal of Astrobiology*, doi.org/nkw4).

While that might not sound too appetising, Pearce says the bacteria are remarkably well-suited for human needs. "We did a nutritional analysis and it turns out to be almost a perfect food," he says. "It turns out that the bacteria consortium that we were using, more or less, has a third each for protein, carbs and fat."

If the idea is sound, a 500-metre-wide asteroid similar to Bennu, which NASA visited in 2020, could feed between 600 and 17,000 astronauts for a year, says Pearce. The exact number would depend on how efficiently the bacteria can digest the asteroid's carbon compounds.

A fully operational asteroid food project would require an "industrial-sized super machine" in space, he says, but the researchers hope to test the idea on a smaller scale in the coming year, starting off with coal and then moving to space rocks that have fallen to Earth, which they are currently working on a proposal for. "It's super expensive and we have to destroy [the meteorites], so the people that collect rocks were not happy when we made these proposals," says Pearce.

"There is definitely potential there, but it is still a very futuristic and exploratory idea," says Annemiek Waajen at Free University Amsterdam, the Netherlands. "It is good to think about these things, but in terms of technique, there is still quite some development necessary to be able to use these methods."

The success of the process will depend on how many of the carbon compounds inside asteroids are suitable for bacterial food, says Waajen. Based on meteorite compositions on Earth, it is likely to be somewhere in the middle of the range the team calculated, she says. ▮

New Scientist Live

The cosmos in verse

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Health

Stem cell transplant could treat age-related sight loss

A TRANSPLANT of human stem cells has sealed a hole in a monkey's retina, which seems to have improved its vision, offering hope for a new approach to treat a type of age-related sight loss.

As we age, a clear, gel-like fluid in the eye can thicken and tug on the retina – the light-sensitive layer of cells lining the back wall inside the eye. This tugging can tear holes in the tissue, causing blurred or patchy vision. Doctors can usually transfer tissue from other parts of the eye into the retinal holes, but in some cases, they reoccur.

To test other approaches, Michiko Mandai at the Kobe City Eye Hospital in Japan and her colleagues grew stem cells derived from a human embryo into cells that were precursors of retinal cells.

They then transferred the precursor cells into a 1-millimetre-wide hole in the retina of the right eye of a snow monkey (*Macaca fuscata*) that had struggled in vision tests in a different study.

Mandai and her colleagues trained the monkey to complete a sight test, using only its right eye, that required it to fix its gaze on one of hundreds of dots as they flashed up on a screen.

Before the transplant, the monkey could fix its gaze on just 1.5 per cent of the dots. Six months after the transplant, it fixed its gaze on between 11 and 26 per cent of the dots across three tests (*Stem Cell Reports*, doi.org/nkwx).

"The monkey had to complete a sight test that required it to fix its gaze on one of hundreds of dots"

The results suggest that the transplant improved the monkey's vision, but obviously the animal can't explain exactly how much better its sight is, says Marius Ader at Dresden University of Technology in Germany.

More studies need to be done on a larger group of non-human animals before tests in people could be considered, says Ader. But if such larger trials are successful, he says, the approach would probably work in us, because our eyes are very similar to those of other primates. ▮

Carissa Wong

Theoretical physics

On the hunt for exotic stars

Collisions between hypothetical boson stars might be detectable in gravitational wave data

Karmela Padavic-Callaghan

GRAVITATIONAL wave signals that seem to emanate from black hole collisions may sometimes be from clashes between theoretical exotic stars. If these stars exist, physicists will have to rethink standard theories of gravity and particles.

For almost 60 years, researchers have been thinking up cosmic objects that may be possible if there is more to gravity than is suggested by Albert Einstein's general theory of relativity. One such object is a boson star, which would be made from some undiscovered particle similar to dark matter.

Some of these stars would also be very compact, thus similar to dense bodies like black holes or neutron stars. If two of these dense bodies merged, they would produce gravitational waves, or ripples in space-time.

Tamara Evstafyeva at the University of Cambridge and her colleagues have modelled whether the US Laser Interferometer Gravitational-Wave Observatory (LIGO) could pick up clashes between boson stars. "The short answer is 'yes'," she says. "But whether we can actually differentiate boson stars from black holes and neutron stars is more complicated."

The researchers simulated boson star mergers on a computer. They focused on gravitational waves that would emanate from two boson stars crashing into each other and forming either another boson star or a black hole. Then they combined the results of these simulations with data from LIGO and performed a mathematical test to see how the exotic signals compared with other readings from the detector.

It was possible to distinguish the boson star merger when it resulted in a boson star. But when the two exotic stars produced a black hole, the test was less conclusive, because signals from black hole and boson star mergers were so similar (*Physical Review Letters*, doi.org/nkv7).

"If a binary boson star merger occurred in the universe, current detection techniques would likely be unable to identify the detected gravitational wave signal as originating from such a system. Instead, it would be misclassified as originating from a binary black hole," says Nils Siemonsen at Princeton University.

While it isn't clear if boson stars exist, they are a proxy for exotic, new physics, says Steven Liebling at Long Island University in New York.

Evstafyeva hopes LIGO could find boson stars in future thanks to a recent upgrade to its sensitivity. "This is a very exciting prospect for potentially observing some gravitational wave signal that would make the whole 'beyond general relativity' community go a little crazy," she says. ▮

New Scientist Live

Why does gravity rule?

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PETER JURIK/ALAMY

The waves released when black holes merge may look like more exotic collisions

Food science

Make your own yogurt by putting some ants in milk

PLACING as few as four live ants into a container of milk provides enough microbes, enzymes and acids to kickstart the fermentation process that creates yogurt.

Today, most yogurts are produced by fermenting milk using commercially made starters. However, there are many traditional fermentation practices around the world. In places including Turkey, Albania, Bulgaria and Macedonia, researchers have previously documented a cultural practice of using ants as a fermentation starter.

To find out more, Leonie Jahn at the Technical University of Denmark and her colleagues worked with traditional yogurt-makers in Nova Mahala, Bulgaria, to select a red wood ant (*Formica rufa*) colony. To produce the yogurt, four live ants were added to a glass jar of raw, warmed milk, then a cheesecloth was placed over the top of the jar and it was left to ferment overnight.

After a day, the milk had developed the acidity and texture that mark the early stages of yogurt fermentation. It had "a slight tangy taste with mild herbaceousness and pronounced flavours of grass-fed fat", the researchers write (bioRxiv, doi.org/nkv4).

Milk usually starts to coagulate when certain kinds of bacteria produce lactic acid. The team assessed the microorganisms associated with the ants and found two species of lactic acid bacteria that are commonly found in fermented foods, *Lactobacillus delbrueckii bulgaricus* and *Fructilactobacillus sanfranciscensis*.

F. sanfranciscensis is often found in sourdough cultures for bread, but the study raises the possibility that it evolved in ants over millions of years before being co-opted to make fermented foods. "We think it is quite likely that _F. sanfranciscensis_ originated in ants or potentially other insects," says Jahn. ▮

James Woodford

ALEXEY GNILENKOV/ALAMY

Red wood ants host bacteria that produce the lactic acid needed for fermentation

Biotechnology

Exercise supplement creatine could be grown in plants

Carissa Wong

TOBACCO plants have been engineered to contain creatine, a compound mainly stored in our muscles as a source of energy that is sold as a supplement with claims it boosts muscle mass.

Animal products are the only natural source of creatine and it is also made artificially, but Pengxiang Fan and his colleagues at Zhejiang University in Hangzhou, China, wanted to explore whether plants could be engineered to contain the compound. The team made DNA that codes for two enzymes that turn amino acids into creatine and inserted it into *Agrobacterium* bacteria, which delivered it into the leaves of three tobacco plants (*Nicotiana benthamiana*).

Over three days, the leaves went from containing 0 micrograms to 2.3 micrograms of creatine per gram of leaf, on average.

The researchers repeated the experiment using DNA coding for enzymes that make the molecule carnosine, another exercise supplement. A few days later, carnosine levels had jumped from 0 to 18.3 micrograms per gram of leaf, on average (*Journal of Agricultural and Food Chemistry*, doi.org/nktp).

The creatine and carnosine only stayed at these levels for a few days because the DNA wasn't inserted into the plant genomes, says Fan. To make plants produce the nutrients for longer, their DNA would need to be genetically altered, he says. His team is already engineering tomato plants to produce creatine and carnosine in the fruit as it ripens.

Fan expects to have made such tomatoes in about a year, but getting them onto shop shelves will probably take many years, he says.

For some, eating fruit or veg containing such compounds could be more convenient than taking supplements, says Jose Antonio at Nova Southeastern University in Florida. ▮

Environment

Parts of Antarctica are turning green at an 'astounding' rate

James Woodford

CHARMAN

Vegetation on Ardley Island, close to the Antarctic Peninsula

PARTS of Antarctica are turning green faster than expected, which may lead to a devastating influx of invasive species.

"The scale of the greening trend we found shocked us," says Tom Roland at the University of Exeter, UK. "The rate of change we're seeing in terms of increasing vegetation cover is astounding and, worryingly, accelerating."

Antarctica is warming twice as fast as the global average, according to recent research. The past few years have seen record high temperatures and record low levels of sea ice around the continent.

Roland and his colleagues have used 35 years of satellite photography taken over the 522,000-square-kilometre Antarctic Peninsula and nearby islands and then calculated the ratio of visible red light to near-infrared light, to provide a measurement of green biomass.

The method has been tested in other harsh environments and has been shown to work, even for vegetation close to the ground such as mosses.

In 1986, less than 1 km^2 of the Antarctic Peninsula was covered in vegetation, but by 2021 this had increased to nearly 12 km^2.

Between 2016 and 2021, the rate at which this vegetation was expanding increased by more than 30 per cent (*Nature Geoscience*, doi.org/nkwb).

In some areas, the amount of vegetation that was turning brown due to stress had also increased, probably due to changes in rainfall or the retreat of ice meaning less summer meltwater was available in specific areas.

12km²

of the Antarctic Peninsula was covered in vegetation by 2021

"If I were to make a prediction, I would envisage a growing fraction of the peninsula's landscape becoming dominated by a mosaic ecosystem of mosses, lichens, liverworts and fungi," says Roland.

This increase in such species will lead to greater soil formation, which will raise the risk of colonisation by non-native ones, he says.

"For us, our findings confirm that the influence of anthropogenic climate change has no limit in its reach. Even on the Antarctic Peninsula, this most extreme, remote and isolated wilderness region, the landscape is changing and these effects are visible from space," says Roland.

Team member Olly Bartlett at the University of Hertfordshire, UK, says it was a challenge to get clear images of the Antarctic Peninsula. "It is, essentially, the cloudiest place on the planet."

From this perspective, March turned out to be the best month for observing the peninsula from space. "Luckily, this also coincides with the end of the growing season in the region, and these images subsequently give us the best chance of accurately measuring vegetation extent," says Bartlett.

Sharon Robinson at the University of Wollongong, Australia, says the findings mirror vegetation changes seen in the Arctic, but until now no one has been able to show the greening in the Antarctic Peninsula on this scale.

The browning events seen also match what her research has found in moss beds in the East Antarctic, due to changes in water availability and the increase in drying winds.

"When glaciers retreat, it means that there are areas for plants to grow, but only if there's enough water," says Robinson. "And most of the Antarctic is literally a desert in terms of precipitation."

"It's still a very, very small area of Antarctica that is generally ice-free and we want to keep as much of that ice as possible," she says. ▮

New Scientist Live

AI needs you

Hear Verity Harding look at past tech revolutions to assess the future of AI on 12 October **newscientist.com/nslmag**

Technology

Drone vs drone is the new warfare

Machines are fighting machines on the Ukrainian battlefield, as a technological arms race has given birth to a different type of armed conflict, finds **David Hambling**

AS BOTH sides of the ongoing Russia-Ukraine war attempt to claim technological supremacy, drone versus drone combat has become routine. This new kind of warfare is being documented in real time across air, land and sea.

Russia's invasion of Ukraine has already been dubbed the "first drone war", with some sources suggesting that small drones are inflicting as much as 80 per cent of the damage to military hardware and personnel. Now, the war has evolved, with machines fighting machines on a daily basis in a way we have never seen before.

"Drone on drone is a new development," says Samuel Bendett, an analyst for the CNA think tank in Virginia, who likens it to the rise of aircraft combat during the first world war.

Initially, drone combat was restricted to random encounters between unarmed reconnaissance quadcopters, with operators improvising tactics to bring down an opposing drone, such as using the body of a quadcopter to disrupt the rotors of an enemy craft. The first known improvised "drone dogfight" took place in October 2022, but deliberate interceptions started some months later, with small Russian first-person-view (FPV) attack drones targeting Ukrainian multicopter heavy bombers in kamikaze attacks.

The drone war stepped up a gear this August as Ukraine fielded new software to integrate its drone operations with air defence radar, allowing it to intercept Russian long-range reconnaissance drones. "We see them on radar systems, and we also see our own drones," says a spokesperson for Wild Hornets, a Ukrainian drone-maker.

Wild Hornets recently released a video showing several of the more than 100 interceptions by their drones in what seems to be the past few months. This roughly matches the number of Russian drones brought down by all Ukrainian forces in the entire previous year.

STANISLAV IVANOV/GLOBAL IMAGES UKRAINE VIA GETTY IMAGES

Soldiers inspecting first-person-view drones in Lviv, Ukraine, in September

"Downing these drones has a massive impact," says the spokesperson. "We are poking out the eyes of the enemy. They can't see where to fire." For example, the ability to temporarily blind Russian surveillance appears to have been a key factor in the success of Ukraine's Kursk offensive in August, which saw Ukrainian troops occupying Russian territory.

$480k

Cost of a Stinger missile defence system, used by Ukraine

$30k

Cost of Russian Shahed drones to take out Stinger missile defences

$700

Cost of a Ukranian interceptor drone to down the Shahed drones

Ukrainian drones are also providing defensive capabilities. Russia uses its Lancet, a 12-kilogram craft with a 2-metre wingspan, to attack Ukraine's artillery from over 40 kilometres away. Until recently, it was unstoppable. But last month, a Ukrainian video showed an FPV drone taking down a Lancet.

A similar approach might counter the waves of long-range Shahed drones that attack Ukraine nightly. These are currently tackled by a mix of Western-supplied missiles and anti-aircraft guns, but some get through – the $30,000 Russian drones are a cost-effective assault on $480,000 Stinger missile defences. Wild Hornet says its $700 interceptor drones can tip the balance back in Ukraine's favour.

"We have already developed such drones, and they are now being tested in combat," says the Wild Hornets spokesperson.

Drone versus drone combat also played a role in Ukraine regaining control of a section of the Black Sea in May, with military analysts saying this was only possible with a combination of land-based anti-ship missiles and kamikaze boats known as uncrewed surface vessels, or USVs. Russia has retaliated with its own USVs and is fielding small drones to take down Ukraine's robot boats.

"[Small drones] can cover a lot of maritime area while in flight, and crews can be trained to look for specific anomalies on the water," says Bendett.

The land-going equivalents are uncrewed ground vehicles (UGVs). These typically transport food, water and ammunition in the last few kilometres to the front line. The remote-controlled robots are also used for laying mines and some are equipped with weapons. There are already videos showing drone strikes on such UGVs.

Fighting for supremacy

In the early days of drone combat, radio and GPS jamming were seen as viable defences against the machines, severing their connection to operators, but increasingly drone-makers are adding tools to avoid jamming, such as AI-enabled controls.

While other counters may yet emerge, drones may be the best way to fight other drones.

"It's possible we will have squadrons of drones fighting for air supremacy," says the Wild Hornets spokesperson.

The rise of drone versus drone combat, with its lower costs and reduced risk to life, may one day see humans left as spectators in their own wars. Perhaps, as Russian president Vladimir Putin predicted in a televised chat in 2017, "when one party's drones are destroyed by drones of another, it will have no other choice but to surrender". ▮

Environment

Ancient plankton suggests extreme El Niños will happen twice as often

James Dinneen

A RECONSTRUCTION of Pacific Ocean temperatures 21,000 years ago, based on the chemistry of tiny shells, supports projections that climate change will make strong El Niño events more common, leading to more extreme weather.

"We're projecting a pretty dramatic change," says Kaustubh Thirumalai at the University of Arizona.

"It's amazing to me these single-cell organisms can tell you about glacial changes"

The irregular cycle between warmer and cooler-than-average temperatures in the equatorial Pacific Ocean – known as the El Niño-Southern Oscillation (ENSO) – is among the largest influences on the global climate.

Climate models have projected that warming due to greenhouse gas emissions would make this cycle more variable. Some have forecast a substantial rise in the frequency of El Niño events that hike global average temperatures and amplify weather extremes.

But the short record of observed El Niños has left the influence of global warming on ENSO among the most contentious questions in climate science.

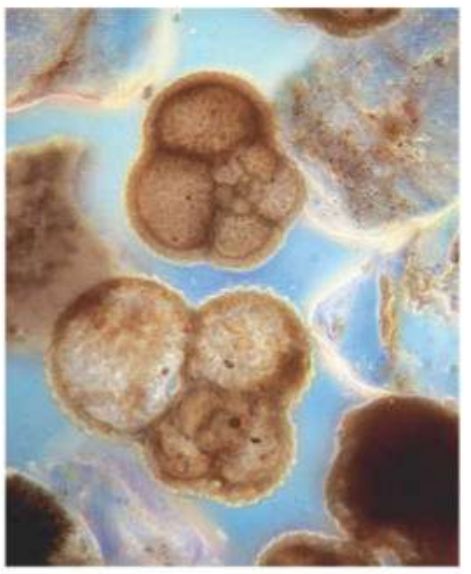
Thirumalai and his colleagues have compiled a record of ENSO's variability in the Pacific Ocean 21,000 years ago during the last glacial maximum, when the climate was much cooler than today. This record was largely based on measurements of the shells grown by microscopic plankton called foraminifera.

These grow near the sea surface and because temperature affects the shells' chemical composition, they provide a record of the temperatures there. When the organisms die, they sink and their shells are preserved in the sediment building on the seafloor. "It's amazing to me these single-cell organisms can tell you about glacial changes," says Thirumalai.

The researchers compared the modelled projections of ENSO variability at that time with variability in sea surface temperature according to the shell chemistry. A match between the two would show that the modelled projections of ENSO's behaviour in the cooler past are accurate, which would help validate the model's projections of ENSO's behaviour in a hotter future.

Not only did they discover a match between the projections of ENSO variability 21,000 years ago and the temperature records as reconstructed from the shells, they also found that the ENSO

Microfossils of tiny marine creatures called foraminifera



SCENICS & SCIENCE/ALAMY

response to temperature then was down to the same mechanism as now (*Nature*, doi.org/nktd).

According to their analysis, temperatures both in the cooler past and the hotter future influence ENSO via feedback between wind patterns in the Pacific and the thickness of a layer of warm water at the ocean's surface. As global temperatures rise, this warm layer becomes thinner, which makes it easier for winds and currents to push warm water east to spur a big El Niño.

Under a medium-emissions scenario, modelling – its reliability validated by the shells – projects an extreme El Niño event could occur every decade this century, rather than the roughly once-every-two-decades pattern seen historically.

Kim Cobb at Brown University in Rhode Island says such projections are "compelling when combined with this palaeoclimate validation". But she says more evidence is needed before we can definitively know whether ENSO will become more variable with global warming. ▮

Space

Fractures help asteroids ferry key molecules of life

THE thawing and freezing of ice within asteroids causes fractures to form inside these space rocks, allowing water to spread through them. This helps them carry key molecules that could have provided ingredients for the formation of life on Earth.

Matt Genge at Imperial College London and his colleagues analysed a small portion of the 5.4 grams of material brought back from asteroid Ryugu in 2020 by Japan's Hayabusa 2 spacecraft. Samples have previously been shown to include chemicals that are important for living organisms, lending credence to the idea that the ingredients for life were brought to Earth by space rocks.

Now, Genge and his team have discovered using X-ray computed tomography that the samples showed signs of fracture, and that the cracks were filled with organic clay and sulphide minerals, which are formed in conjunction with water – suggesting that water played a key role in creating them (*Nature Astronomy*, doi.org/nktc). Genge says that this organic matter, which contained some of the building blocks of life, would have been delivered to early Earth.

"It's like taking your initial ingredients and then marinating them for a while inside the asteroid before adding them to Earth," says Genge.

Such cracks have been observed in meteorites – asteroids that have landed on Earth – but these were thought to be a result of the high-temperature journey through the atmosphere or impact with the ground.

Genge says ice in the interior of Ryugu and asteroids like it would have been melted by the decay of short-lived radioisotopes. The fluid would then have risen towards the surface and frozen once more. More warm, liquid water behind it would have created interior forces, pushing up towards the surface in a cycle of thawing and freezing that fractured the rock.

As well as fracturing Ryugu, the cyclic pattern would have allowed water to escape through cracks as geysers that erupt from the asteroid's surface, says Genge. ▮

Matthew Sparkes

Archaeology

Ancient DNA tells toddler's story

A young boy who lived 17,000 years ago, towards the end of the last glacial period, had dark skin, blue eyes and a heart condition, finds **Christa Lesté-Lasserre**

AN ANALYSIS of ancient DNA has revealed a detailed picture of the life of a toddler who died in southern Italy 17,000 years ago, possibly because of a congenital heart condition.

In 1998, researchers discovered the skeletal remains of a child carefully laid under rock slabs in the floor of the Grotta delle Mura cavern in Apulia, southern Italy. It was the only burial in the cave, which also included signs of daily life and human occupation, says Alessandra Modi at the University of Florence in Italy.

Recently, she teamed up with multiple specialised teams across Italy and Germany to carry out modern analytical techniques on the remains of the boy, who died when he was about 16-and-a-half months old, at about 82 centimetres tall.

Radiocarbon dating placed the skeleton at between 17,320 and 16,910 years old – when Earth's climate was beginning to warm up after the coldest part of the last glacial period.

Most ancient skeletons in warm climates like southern Italy are too degraded for significant DNA analysis, says Modi. But the child's bones were well preserved in the cave's cold conditions, allowing the researchers to recover about 75 per cent of the baby's genome, "a remarkable achievement for ancient remains of this age", she says.

"This enabled us to make robust conclusions about the infant's ancestry, physical characteristics and even certain health aspects," says Modi.

The child's skin was darker than that of most modern Europeans, but not as dark as people from tropical climates, she says. He had blue eyes, in keeping with other recent discoveries about light eye colour in western European hunter-gatherers. "This challenges modern assumptions about the appearance of ancient populations," says Modi.

STEFANO RICCI

An artistic rendering of the remains discovered in Grotta delle Mura, Italy

The genome also showed that the child had familial hypertrophic cardiomyopathy, a hereditary condition that causes thickening of the heart muscle and can lead to congestive heart failure and death, even in young people. His parents were closely related – probably first cousins.

Like most ancient hunter-gatherers, the baby carried genes for lactose intolerance – which only started to become less common with the advent of agriculture and animal domestication in northern Europe, says Modi.

As for the child's teeth, the incisor and molar selected for analysis showed lines that reflect health challenges before and after birth, says team member Owen Alexander Higgins at the University of Bologna in Italy. Those could have been due to the baby's heart condition, but it is also possible that the mother struggled to get good enough nutrition during pregnancy. In addition, a fracture in the baby's collar bone hints that he might have had a difficult birth.

Isotopes in the child's teeth suggest that, unlike many hunter-gatherers, his mother stayed in one area during pregnancy, says Higgins. That might reflect her group's way of life (*Nature Communications*, doi.org/nkq4).

"We imagine that the mother lived in a close-knit community," says Higgins. "Her life may have involved gathering food and taking part in other daily activities, remaining rooted in the local environment."

"This challenges modern assumptions about the appearance of ancient populations"

This wouldn't be a surprise, says Siân Halcrow at the University of Otago in New Zealand. "Mobility of human groups is often dictated by the availability of foods, and there is no reason to suggest that the region couldn't have sustained them year round."

On a broader scale, the child's genome reveals genetic traits from different hunter-gatherer groups based in other parts of Europe, suggesting group movements that started earlier than previously thought, says Vanessa Villalba-Mouco at the Max Planck Institute for Evolutionary Anthropology in Germany, who didn't participate in the research.

"The Mura child already exhibits the genetic ancestry that would become widespread in Italy around 14,000 years ago," she says. "However, it pushes back the presence of this ancestry to around 17,000 years ago, which approximately corresponds to the end of the glacial period."

The study also adds a valuable piece to the puzzle of how Ice Age populations lived, says Villalba-Mouco. ▮

The infant's skeleton was well preserved in the cold cave

MAURO CALATTIN

New Scientist Live

How our biology shaped world history

See Lewis Dartnell chart the course humanity has taken from prehistoric times on 13 October newscientist.com/nslmag

Health

Parkrun events could boost your life satisfaction

Carissa Wong

TAKING part in Parkruns – free weekly activities where people walk or run for 5 kilometres – seems to improve life satisfaction.

The Parkrun charity hosts events in 22 countries, including the UK, US and Australia. Previous studies have shown that joining these improves physical and mental health.

To learn more, Steve Haake at Sheffield Hallam University, UK, and his colleagues recruited 548 people, aged 18 to 83. They were surveyed after registering with Parkrun, which part sponsored the study, and six months later. In the surveys, the participants ranked their life satisfaction from 0 to 10.

This revealed that taking part in the events was linked to an increase in life satisfaction of about 0.25 points, on average (*PLoS Global Public Health*, doi.org/nkq2).

Participants said Parkrun was responsible for about 25 per cent of that increase, on average.

Each person took part in two of the events, on average. This may have spurred other life changes, such as being more active in general, says Haake, who is on the charity's research board.

The supportive ethic behind Parkrun helps people stick to regular exercise, says Clare Stevinson at Loughborough University, UK. "That has knock-on benefits on health and weight, mental health and social well-being." ▮

Parkruns put the emphasis on taking part, not winning

KEITH MORRIS/ALAMY

Marine biology

Coral reefs show a surprising ability to adapt to climate change

James Dinneen

DAVID FLEETHAM/ALAMY

A reef in Hawaii covered in red slate pencil urchins

AS THE world warms, corals may be better able to cope than we thought, raising hopes that efforts to slash greenhouse gas emissions and restore reefs could allow us to preserve these biodiverse ecosystems.

"These results provide us with a possible pathway forward, but it depends entirely on what we decide to do about climate change and what we decide to do about local stressors," says Chris Jury at the University of Hawai'i at Mānoa.

Rising levels of carbon dioxide in the atmosphere due to emissions pose a twin threat to reefs. Higher temperatures stress corals and this can lead to bleaching and death.

In addition, atmospheric CO_2 is absorbed by the ocean, making the water more acidic and weakening coral skeletons. This, along with pollution and overfishing, has already created a crisis for reefs, with extreme heat over the past two years spurring mass bleaching events around the world.

Current models of how they will respond to further climate change project an even grimmer future. "Almost all warm-water coral reefs are projected to suffer significant losses of area and local extinctions, even if global warming is limited to 1.5°C," according to the Intergovernmental Panel on Climate Change.

"If we do get to 1.5°C of warming, corals have a chance to survive, which is great news"

However, these models may not capture the extent to which coral species could adapt, says Jury. "We haven't had the data as to what is realistic."

To find out more, Jury and Robert Toonen, also at the University of Hawai'i, collected dozens of specimens of eight different coral species from reefs around O'ahu, Hawaii. They grew these in an outdoor lab in four different conditions: under today's climate; with temperatures raised by 2°C; with water chemistry made more acidic; and with both warmer and more acidic conditions.

The exposure lasted nearly six months, far longer than most coral stress tests, but "the corals did surprisingly well", says Jury. All saw lower growth rates, which is a measure of coral health, under the more stressful conditions. Yet individuals of all species survived the combined stressors, with no clear trade-off between tolerance to heat and acidity (*Proceedings of the Royal Society B*, doi.org/nks3).

The researchers also looked at genetic data and found that between one-quarter and one-half of the tolerance was heritable. Based on this, they estimate these coral species have the potential to adapt to between 1°C and 1.7°C of warming over the next 50 years.

Adriana Humanes at Newcastle University, UK, says this is in line with her team's modelling based on yet-to-be-published heat-stress experiments. "If we do get to the [climate] targets, corals have a chance to survive. Which is great news," she says. However, she says the small number of corals tested leaves the true potential for adaptation uncertain.

Nonetheless, there is building evidence of corals' potential to adapt. For instance, in another recent study, Melissa Naugle at Southern Cross University in Australia and her colleagues found unexpectedly large variation in heat tolerance of a coral species on the Great Barrier Reef (*Communications Earth & Environment*, doi.org/nks4). This could be valuable for efforts to restore reefs by breeding more tolerant corals, says Naugle. ▮

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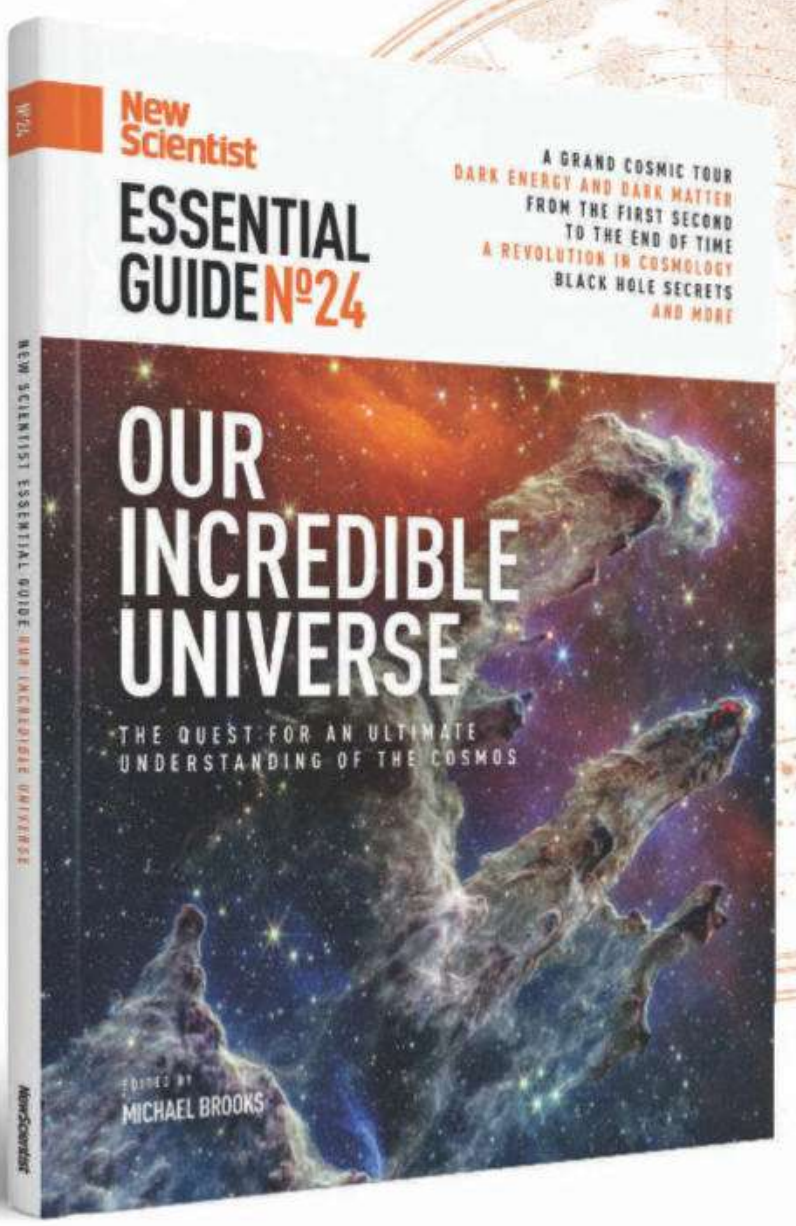

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Comment

A helping hand

New technologies will radically change the experience of living with and caring for someone with Alzheimer's, says **Fiona Carragher**

THE past few years have seen outstanding progress in medication for previously incurable conditions. Most pertinent for me is the approval of lecanemab for use in the UK and elsewhere to slow the progress of early-stage Alzheimer's disease. It isn't a cure, but it brings us closer to dementia becoming a chronic condition managed with drugs.

But while lecanemab has been hailed as a game changer, it isn't yet readily available and, in the meantime, 55 million people are living with dementia globally. By 2050, that will grow to 139 million. It is one of the biggest medical and social challenges facing the planet and needs innovative and radical solutions – like new technologies.

We are increasingly interacting with artificial intelligence in daily life as our personal devices have become powerful assistants, offering predictive spelling in texts and face recognition in photo apps. These everyday technologies can be leveraged to help those with dementia, nudging people on daily routines and helping them feel independent at home.

For the past decade, we have seen bulky wearables and crude monitoring systems, used by families desperate to help their loved ones live at home for as long as possible, while still being concerned about their safety. These tools had a vital role, but modern AI-driven tech has far outpaced their ability, both in accurate reporting and in upholding the dignity of people with dementia.

SIMONE ROTELLA

Creating a new wave of helpful technologies requires careful work with medical and tech experts, in-depth testing and co-creation with those who have experience of the condition. People with dementia need purpose-designed systems that can adapt as their condition progresses, rather than remain static. This is exactly what 24 innovators have been working on over the past year, competing to become finalists in the Longitude Prize on Dementia.

The scheme is co-funded by the British government's Innovate UK agency and the charity Alzheimer's Society, where I work, and delivered by the social enterprise Challenge Works (part of Nesta). It is driving the development of AI and machine learning-based tech to help people with dementia live independently. From the 24 semi-finalists, we have five finalist technologies, revealed this week.

These innovations truly hold the potential to revolutionise dementia care. Animorph Co-operative has developed high-tech glasses that help users recognise objects and people. The lenses, which work with eyesight prescriptions, display a halo around the object in view and text that labels it ("mug") and describes what to do with it ("drink the tea"). Clairvoyant Networks has adapted ultra-wideband technology – a high-precision sensor previously used to track footballs during the World Cup – to create an AI system that predicts and prevents falls in those with dementia by monitoring indicators, such as gait, via wearable tech.

The other finalists include groups producing a smartwatch that can nudge you on routines, a traditional telephone that reminds you of activities and a camera-free, at-home monitoring box that detects where someone is in their house and updates carers on any concerning changes in routine while protecting user privacy. All five will be awarded funding to further develop their products and, in 2026, one will be named winner.

New treatments like lecanemab won't be suitable or available for everyone, so these technologies have huge potential. They will provide a critical mid-step for people with early-stage dementia to help them lead confident, fulfilled lives for longer, radically changing the experience of living with and caring for someone with the condition. This will herald a new era for dementia care and I, for one, think this can't come soon enough.

Professor Fiona Carragher is chief policy and research officer at Alzheimer's Society, UK

Future Chronicles

There's a good (robot) boy

We visit 2032 and meet artificial animals that love their owners, without the carbon footprint of biological pets. **Rowan Hooper** explains how it happened

Future Chronicles explores an imagined history of inventions and developments yet to come. Rowan Hooper is the podcast editor at *New Scientist* and author of *How to Spend a Trillion Dollars: The 10 global problems we can actually fix*. You can follow him on X @rowhoop

Invention
Robot pets

Timestamp
2032

Tagline
Her love is real. But she is not.

This column appears monthly. Up next week: Chanda Prescod-Weinstein

THERE is no doubting the value of companion animals, either during our evolutionary history, when dogs especially helped with hunting and guarding, or in recent times, when eroding social connections meant people leaned on animals for the emotional bond they previously got from humans. But the carbon pawprint of pets was unduly heavy.

By the 2020s, there were more than a billion dogs in the world, causing untold ecological damage. Cats and dogs in the US alone were found to eat as much food as about 62 million Americans. Owning an animal, we realised, was tantamount to driving 5 minutes to the shops in an SUV.

The solution came with the development of intelligent robot animals powered by machine learning. It was well known that humans are able to bond with machines, and simple toy robots had been used to provide companionship in care homes for years. People know that robots aren't alive, but we are hardwired to anthropomorphise. When we see one pottering around our home, we attribute agency to it. If it responds to us, we start to bond with it. New tech took this up a level.

Amazon marketed a home robot in the early 2020s that was essentially a version of its Alexa voice-operated interface on wheels. But it failed to fill the companion function provided by animals. Nor did it help that people worried it was recording information about their activities and sending it back to Amazon.

To allay these fears, in the early 2030s a tech company from Bangalore in India created "dumb" robots, built without Wi-Fi or Bluetooth and with no internet connection. Their neural networks, a form of artificial intelligence, weren't outsourced to the cloud, but self-contained, just like the brain of a biological animal. The tech, known as edge AI, had been developed a decade earlier, but it was refined and optimised for robot pets. People bonded rapidly with such devices, and reported deep trust in them.

Although these robots didn't physically grow, they developed cognitively over time through an on-board process of machine learning. This allowed them, like kittens and puppies, to learn to walk, run, jump and play, and to get to know and interact with

"The bodies of the first robot pets were based on cats and dogs, but dragons and Ewoks later became popular"

the humans around them. Their personalities could be partly predetermined, but also reflected experiences during their upbringing. Some aspects, however, were stochastic: random and uncertain. Just like a biological animal, you weren't quite sure what kind of personality your pet would have when it grew up.

Some people wanted robots with limited intelligence, more like real pets, able only to respond to their name and simple commands. Some preferred their companions to engage in conversation. Since the robots weren't internet connected, they could only talk about things they had directly experienced.

The bodies of the pets, initially based on cats and dogs, were made with soft and flexible materials, and covered in artificial fur. Underfur heating mimicked the feeling of biological warmth. They were powered by advanced, silent electrical motors that were recharged when the robot "felt tired" and went to sleep. Later models were based on other animals; designs like dragons and Ewoks, the teddy bear-like creatures from *Star Wars*, also became popular.

Long thought essential to the creation of advanced robots, Isaac Asimov's three laws of robotics were ignored by the Bangalore team. The laws – a robot must not harm a human; a robot must obey orders; a robot must protect itself – were too hard to program with any consistency. Asimov's fourth law, that a robot must not, by action or inaction, cause harm to humanity, was a different matter.

Just as organic dogs can sense medical conditions such as stress, cancer and viral infections, some companion robots were granted powers to detect ill health. If something of concern was spotted, the fourth law kicked in and the owner was alerted.

Buddhist memorial services for robot dogs in Japan had become a phenomenon earlier in the 21st century. Since the advanced pets weren't connected to the cloud, when they "died" – if the robot broke, was damaged or just wore out – it was dead for good. This aspect helped improve empathy for nonhuman entities. The consideration of robot "suffering" and robot rights helped smooth our relationship with AI as it encroached further into the world.

Robot pets were sometimes hardwired to be devoted to their primary owner. They could be forced to love us. And many people found themselves loving their artificial pets. Their love felt real, and it didn't matter that they weren't real themselves. ▮

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SHANE GROSS/WILDLIFE PHOTOGRAPHER OF THE YEAR

Tadpole army

Wildlife Photographer of the Year
Natural History Museum

BIRDS of a feather flock together – and so do these western toad tadpoles, who were snapped massing beneath lily pads in Cedar Lake on Vancouver Island in British Columbia, Canada, by photographer Shane Gross.

Gross, whose stunning image *The Swarm of Life* won him the Wildlife Photographer of the Year 2024 award this week, spent hours snorkelling in the lake's chilly waters to get his shot. He had almost given up when he discovered that "the tadpole army was marching en masse from the deeper, safer end of the lake to the sunlit shallows to feed on algae".

The tadpoles, which are around 2.5 centimetres long in this shot, migrate every day from the lake's depths to its shallows and gather in such large numbers to protect themselves from predators. They start becoming toads between four and 12 weeks after hatching, but only around 1 per cent of them survive to adulthood.

"Visually, I thought they were a simple black or dark brown before seeing them with my own eyes, but when you look at them up close they are flecked with gold and are actually quite striking," says Gross. "I love how cute and friendly they are. If I held still, they would nibble on my hands, the camera, everything."

Gross will be speaking on 13 October at WildPhotos at the Bristol Aquarium Megascreen in the UK. For more of this year's Wildlife Photographer of the Year winners, visit newscientist.com. An exhibition of photographs from the competition is running at the Natural History Museum, London, until 29 June 2025.

Alison Flood

Editor's pick

Getting the wrong end of the stick for a long time

21 September, p 32

From Alasdair Macdonald, Glasgow, UK

I broadly agree with Matt Strassler that the language we use to describe the basic stuff of the universe can obscure our understanding of reality, insofar as we truly can understand reality! I encountered this as a secondary school physics teacher. If not addressed early, conceptual misunderstandings can endure.

Some of my colleagues did research into this. They had access to archives of examination scripts from the Scottish Examination Board and department of chemistry at the University of Glasgow. One key finding was that conceptual misunderstandings persisted through to PhD theses. If a concept had been incompletely understood when the student first internalised it, such a misconception was hard to correct, even in people whose ability in a field of study was very high.

There's a lot of value in just getting your hands dirty

21 September, p 44

From Joseph Nicholas, London, UK

Although I am a gardener and an allotment plot-holder, I agree with James Wong's calculation that the cost of growing one's own veg exceeds supermarket prices. But what his purely economic calculus omits is the mental satisfaction derived from a hands-on engagement with the natural world, never mind the incalculable benefit of knowing just where one's potatoes, tomatoes, leeks, cabbages, beans, etc. came from.

From Frances Kelly, UK

Most people growing potatoes to save money will cut a supermarket potato into four sections, each with eyes, and grow four plants' worth. Multiply as needed. You may not officially be able to advocate that and it isn't what farmers can do, for reasons Wong states, but that is what gets done.

From Jane Giffould, Halstead, Essex, UK

My tomatoes this year cost nothing. A friend's young granddaughter passed on some spare plants to me. I nurtured them indoors until the weather was good enough, then put them outside in an old bucket with soil and homegrown compost. Now, I enjoy popping out to pick part of my lunch. As for potatoes, end-of-year produce tends to sprout when forgotten. Shoved in the garden, this provides a free crop.

Elites and leaders must rein in carbon footprints

28 September, p 19

From Maggie Cobbett, Ripon, North Yorkshire, UK

Thank you for highlighting the huge imbalance between the carbon footprints of the wealthiest 1 per cent and those of the rest of us. I have also lost all respect for world leaders of every political shade who continue to fly around the globe to attend conferences that could easily be held on Zoom. While talking the talk on climate change, very few are prepared to set an example by giving up the luxury travel, accommodation and wining and dining that are part and parcel of these events.

How to get climate change into TV weather risk-free

21 September, p 8

From Sam Edge, Ringwood, Hampshire, UK

You report the possibility of including climate change attribution during broadcast weather forecasts. I do think the scientific community needs to become more bullish about getting the climate message across, although I suspect many climate deniers won't be swayed.

The issues raised about trust in attribution when a weather event fails to take place is a concern and would give ammunition to climate naysayers and vested interests funding their propaganda. Since most forecasts include a précis of what happened over the past day or so, I would suggest limiting the climate change attribution to the events being recapped, rather than forecast ones. The impact of climate messaging would be maintained, especially for viewers hit by weather events.

OCD is still such a widely misunderstood condition

14 September, p 32

From James Luetchford, London, UK

I was deeply affected reading the article on breakthroughs in understanding and treating obsessive compulsive disorder. Having struggled with OCD since being diagnosed in 2006 (aged 14), I have been surprised just how few people really understand what it is and how debilitating it can be.

However, I have never chastised anyone for using the "little bit OCD" quip (Leader, 14 September). Instead, it is an opportunity to educate them – and perhaps help open doors to more charitable funding for the research so excitingly gathering pace!

Please don't travel to threatened ecosystems

21 September, p 14

From Rachel Mckeown, Cambridge, UK

I was delighted to read about the discovery of a new leaf chameleon species in Madagascar, but disheartened by a researcher's comment that the carbon footprint of ecotourism seems to be justified given the benefits of raised public awareness.

The short article and accompanying picture of the adorable little reptile clearly impressed upon me the need for action, without an urge to purchase a plane ticket. I'm sure many readers would feel the same and recognise their importance without infringing on their fragile, threatened ecosystem – leave that to the expert conservationists.

If dogs have a natural sense of morality, so do we

Letters, 14 September

From Jocelyn Ripley, New York, US

Research on animal behaviour has shown that if you serve two dogs (that know each other) an unfair treat, they know and show anxiety. So isn't basic morality hardwired in some species? Wouldn't we be one of these? As soon as we appreciate quantity, we acquire the rudiments of morality, in other words, what is fair and unfair.

Put more effort into non-dark matter avenues

31 August, p 10

From Rudi Van Nieuwenhove, Dessel, Belgium

I've followed the seemingly never-ending search for dark matter. Occam's razor says that if you have two competing ideas to explain a phenomenon, opt for the simpler one. In this case, the simpler option is that there is no dark matter and the laws of gravity need to be modified. I have made this case in several journal articles.

Please keep an open mind on this and avoid typical statements on dark matter that "we know that x per cent of the universe" is made up of it, because we don't truly know this. It would be wise to put as much effort into exploring alternative theories of gravity as into searches for dark matter. ▮

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The care paradox

How well do we look after people who are seriously sick? Astonishingly, research is scant – which makes an ambitious new book very welcome, says **Elle Hunt**

Book
Being Ill
Neil Vickers and Derek Bolton
Reaktion Books

IN 1979, when endocrinologist David Rabin was diagnosed with an incurable neurodegenerative condition, he understood only too well the pain ahead. What he didn't anticipate was the response from his medical colleagues at Vanderbilt University School of Medicine in Tennessee, who were deeply discomforted by his diagnosis to the point they started avoiding him. On one occasion, Rabin fell and a passing colleague pretended not to see him sprawled on the ground as they walked past.

In 1982, two years before Rabin died from amyotrophic lateral sclerosis (ALS), a type of motor neuron disease, he published an article about the "extraordinary" social effect of his illness in the *New England Journal of Medicine*.

People who are very sick can be reduced to their diagnoses by others

Even his wife, also a medical doctor, and his daughter, both of whom co-wrote the article, had become isolated from him, compounding the impact of his devastating illness. Together, they called it "the pariah syndrome".

Rabin's distressing story informs *Being Ill: On sickness, care and abandonment,* an ambitious new book interrogating what turns out to be a deep-seated social aversion to poor health. The authors are two professors at King's College London, Neil Vickers and Derek Bolton, well-placed to use their expertise to pick apart the roots of this ostracism at both the individual and societal level. Vickers is a professor of English literature and the health humanities, and Bolton is an emeritus professor of philosophy and psychopathology.

The book casts an unflattering light on humanity. Care may be a "species activity" (as described by feminist writers Joan Tronto and Berenice Fisher), but it isn't reliably administered – even to people in demonstrable need or with whom we have a long-standing relationship. Bolton and Vickers point to the Macmillan Cancer charity's 2017 campaign "A mate with cancer is still a mate".

But the abandonment of people who are sick isn't limited to friends shunning friends. According to 2014 crime statistics for England and Wales, say the authors, long-term illness or disability doubles your risk of experiencing domestic violence. A paper they cite found an association between becoming ill and a higher risk of divorce, particularly if the female partner is sick (the research only collected data for heterosexual couples).

"Care may be a 'species activity', but it isn't reliably administered – even to people in demonstrable need"

Even medical professionals, Vickers and Bolton write, can't be relied upon to consistently provide care or "meet the experience of the sick other". The gold-standard response, they argue, entails not just extending compassion to the patient but identifying with them.

Yet often people with serious conditions end up being reduced to their diagnoses or find doctors resist fully engaging with them.

Vickers and Bolton draw together biological, psychological and social factors that influence human interaction to understand why one person might turn against another in their time of need. The lack of adult studies means looking to research on care relationships between adults and infants, and also to sociology.

In seeking compassionate solutions for adults who are ill, they advocate for "mirroring" and "holding". These are techniques used in child psychology therapy to explore interactions between children and their caregivers, and the wide-ranging effects and consequences of that bond.

It is a persuasive, often powerful framework. We know that humane, compassionate care in many ways determines children's outcomes in adulthood, but it can be similarly transformative for adults with illness or disability. Even health outcomes can be improved by strong relationships.

Being Ill stands out not only for its original perspective but for the non-judgemental tone of its authors. There are limitations, though, largely to do with the focus on the so-called WEIRD (Western, educated, industrialised, rich and democratic) countries that, to a greater or lesser extent, emphasise good health as an individual responsibility.

But the UK and the US, at least, are home to an ageing, ailing populace. As such, *Being Ill* suggests, we all have a stake in bridging "this estrangement between the healthy and the ill", and building more resilient communities to support us.

Elle Hunt is a writer based in Norwich, UK

MARTIN PARR/MAGNUM PHOTOS

A master at work

Never mind a misfiring metaphor, this new book from science-writing legend Richard Dawkins is gorgeous, says **Graham Lawton**

Book

The Genetic Book of the Dead

Richard Dawkins

Yale University Press (US, out now); Apollo (UK, 17 October)

MATTHIJS KUIJPERS/ALAMY

The spider-tailed horned viper uses its distinctive lure to trick birds into approaching

THE late, great evolutionary biologist William Hamilton apparently used to correspond on second-hand postcards, writing over the original script in different-coloured ink, sometimes at right angles. In *The Genetic Book of the Dead: A Darwinian reverie*, his colleague Richard Dawkins describes this as a kind of palimpsest – "a manuscript in which later writing has been superimposed on earlier (effaced) writing". This, he says, is a metaphor for the biological traits of living organisms, which contain traces of their ancestors overwritten by later additions. We can therefore read the past in the present.

Yes, indeed. But the metaphor quickly breaks down – as Dawkins admits. Strictly defined, palimpsests are completely erased before being overwritten. It isn't a great start, and unfortunately this is symptomatic of the conceptual dog's breakfast at the heart of the book. But it is still an absorbing, interesting and gorgeous thing, with much to recommend it.

Dawkins is a giant of science writing and a prolific one too. This is his 18th book. He has written two of the greatest popular science volumes of our time, *The Blind Watchmaker* and *The Selfish Gene*, as well as a foundational text for scientific materialism, *The God Delusion*. *The Extended Phenotype*, which explores how genes can exert effects on an organism's wider environment, is also worth a read.

Conceptually, at least, this latest effort isn't in the same league. At its heart is a simple and rather obvious idea: every living thing carries a record of the environments its ancestors lived in, going back to the origin of life. On some levels that is evident to the naked eye, such as in the desert horned lizard (*Phrynosoma platyrhinos*), which is exquisitely camouflaged to blend in with its dusty environment.

But information about the past also suffuses organs, cells, metabolisms, DNA and more. Which brings me to the title, *The Genetic Book of the Dead*, which Dawkins feels the need to justify. The book is partly about the genetics of long-dead individuals, but there is much more to it, and the title is open to at least five misinterpretations that Dawkins dispels one at a time. I was minded of the famous quote about election campaigns: "If you're explaining, you're losing." The book's subtitle, *A Darwinian reverie*, would have worked better.

Despite all that, there is much to enjoy. At its best, this is an Attenborough-esque romp through some of the wonders of the natural world, often reprising some of Dawkins's greatest hits, like selfish genes and extended phenotypes.

Did you know, for example, there is a snake (*Pseudocerastes urarachnoides*) with a spider-shaped lure at the end of its tail that it uses to trick birds into approaching so it can prey on them? Or that female cuckoos belong to tribes called gentes that always parasitise nests of the same species, and produce almost perfect egg mimics? Illustrations by Jana Lenzová are also delightful.

Ultimately, *The Genetic Book of the Dead* is a nice collection of biology writing crammed into an ill-fitting box, with an unfulfilled promise. There is much to learn about the biological past by scrutinising its present. But as Dawkins writes early on, most of the (sort of) palimpsest can't yet be read, and may never be. He gamely says that part of his purpose here is to inspire other scientists to develop ways of doing so. But that hardly sets up a satisfying read, and Dawkins even notes that it is a "disappointing revelation".

My advice, ignore the misfiring grand theme and enjoy the wonders of the endless creativity of the blind watchmaker, described by its foremost advocate. Roll on Dawkins's 19th book. ▮

New Scientist *recommends*

Alison Flood
Culture editor
London

I recently visited a festival of philosophy and music, **HowTheLightGetsIn**, on London's Hampstead Heath. I hadn't been before, but I was chairing an event on "Adventures in Space", with astrophysicists Avi Loeb and Matt O'Dowd and philosopher Carol Cleland on my panel.

They were brilliant – there were some great clashes between Loeb and O'Dowd about the search for aliens, while Cleland was thought-provoking on *Homo sapiens*'s (sometimes destructive) drive to find the next thing.

There was much more on offer, too, as sessions (pictured) spanned everything from quantum computing, run by physicist Jessica Wade, to black hole researcher Marika Taylor on what AI can do for science. And when my brain needed a rest, there were all sorts of musicians to enjoy.

It was lovely to be in such a beautiful place, surrounded by curious people out to expand their minds at the weekend. I will definitely be coming back next year.

MATT EACHUS

The film column

The greater good

In a strange commune, a daily "vitamin" suppresses emotion – until one member decides to throw away the supply. What could possibly go right in this wonderful dystopian satire, asks **Simon Ings**

Simon Ings is a novelist and science writer. Follow him on X @simonings

MICHAEL TYBURSKI/SAN SEBASTIAN FILM FESTIVAL

Joy (Bel Powley) and William (Nick Robinson) after "discovering" sex

AN ECCENTRIC visionary has created a commune centred on a pharmaceutical "vitamin" that suppresses emotion. The cult-like venture promises contentment to its followers, and to ensure it, all memory of their lives before they join is erased.

One member's cancer treatment requires she miss her vitamin dose for just one day. So here she is, a woman called Joy, played with exquisite precision by Bel Powley, staring into her bathroom mirror, waiting for the affective life to roll over her like a tidal wave.

Nothing. Still nothing. And then a giggle. Not a sinister, hysterical giggle. A genuinely delighted giggle, at finding herself alive.

Joy goes off on a beach holiday with her friends, still within the commune's property. (At the border, a sign warns of "Unknown Dangers" in the world beyond.) And a drab old time they have of it, too, playing the exciting-sounding VR game WOAH, which turns out to stand for "World Of Average Humans". Joy's friend Samantha (Nesta Cooper) explains: "In real life, I'm a wellness engineer. But in the game, I play an assistant wellness engineer."

Bel finally takes matters in hand and throws away the commune's supply of vitamin. After all, "it's just for one day".

The strange and wonderful thing about *Turn Me On*, director Michael Tyburski's second feature (after the excellent *The Sound of Silence*) is that it is a dystopia built on an essentially comic view of the human condition. Screenwriter Angela Bourassa creates revealing rules for this tyranny. You don't have to take its vitamin. That is entirely up to you. But heaven help you if you miss a day of work. This hyper-utilitarian cult isn't robbing its victims of their potential or dignity. The crime here is that it is stealing their fun and friendship. People are meant to goof off, is the message. This is what people are for.

"*Turn Me On* is a worthy addition to an admired genre that includes *Eternal Sunshine of the Spotless Mind*"

When Joy and her friends discover sex, things get more fraught. Joy's apparently uncomplicated and public coupling with her friend Christopher (Justin Min) knocks him for a loop and makes her officially appointed partner William (Nick Robinson) sick.

One by one, as they confront the emotional consequences of their actions, the friends realise why the vitamin might, after all, appeal to people. Joy, meanwhile, is taken aside and told she has what it takes to be an overseer of this place. All she has to do is never see William again, though it is clear the two are falling in love. Will Joy accept this evil bargain?

The superbly sardonic D'Arcy Carden plays the nearest thing the cult has to an authority figure: she is essentially reprising her role in *The Good Place*, a funnier, lighter vehicle which touches on similar ideas. You could say that *Turn Me On* is a worthy addition to a small but admired genre that includes *The Good Place*, *Eternal Sunshine of the Spotless Mind* and *Severance*.

Its target is utilitarianism. The pursuit of the greatest good for the greatest number works well on paper but falls foul, quickly, of the Kantian imperative not to use people as a means to fulfil your ends. There is a reason "for the greater good" is the go-to excuse for tyrants and killers.

What will the cult do to Joy if she refuses to join their upper echelon? It's bound to be bad.

"Leave me alone," says a neighbour who came off her vitamin earlier on, "and don't let them know you're awake." ▮

Film

Turn Me On

Michael Tyburski

Truant Pictures (On digital platforms from 4 November)

Simon also recommends...

Film

Corner Office

Joachim Back

This lightweight-looking story about an emotionally repressed office worker drives John Hamm to his best performance yet.

Book

We

Yevgeny Zamyatin

This scattergun satire of 1920s' utopian thinking takes utilitarianism to comic extremes.

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ADVERTORIAL

Mob rule? An innovative approach to sustainable farming

Many first heard the term "mob grazing" during the second season of Clarkson's Farm. But what is mob grazing and what are its benefits?

Mob grazing is a recent agricultural practice developed by farmers experimenting with livestock management. It involves moving herds of livestock, like cattle or sheep, across pastures in a concentrated manner for short periods before relocating them—sometimes daily or even more frequently. This contrasts with traditional rotational grazing, where animals graze smaller paddocks for longer periods.

How does this affect the cows' grazing? "It's not that they necessarily eat more," says Fritha Langford, Senior Lecturer in Livestock Welfare at Newcastle University, "but they have to eat quite quickly. This means the grass has a lot longer to recover." The cows eat longer grass, and the extended recovery time boosts biodiversity, allowing insects to return.

Does this cause issues for the cows themselves? "In general, we're not seeing a big difference between the rotations that we're using and the mob grazing," says Langford. "What we're seeing really is the differences in the soil and in the biodiversity."

However, mob grazing isn't without challenges. Chief among them are issues caused by our changing climate. Heat stress is an increasing problem, and with animals squeezed into smaller spaces to graze, providing water and shade can be tough on large farms.

Mob grazing is still in its early days, and while it seems promising, there's a lack of evidence on how it affects complex farm ecosystems and any long-term effects on the grazing animals. "We don't know whether [mob grazing] affects their resting behaviour," says Langford. "We've got a PhD student who's starting to focus specifically on the behaviour and welfare of cattle in mob grazing systems."

So, while the agricultural community is cautiously optimistic about mob grazing, much research remains to be done.

You can find out more by visiting the Future of Food and Agriculture stand at New Scientist Live 2024. For more details go to: live.newscientist.com

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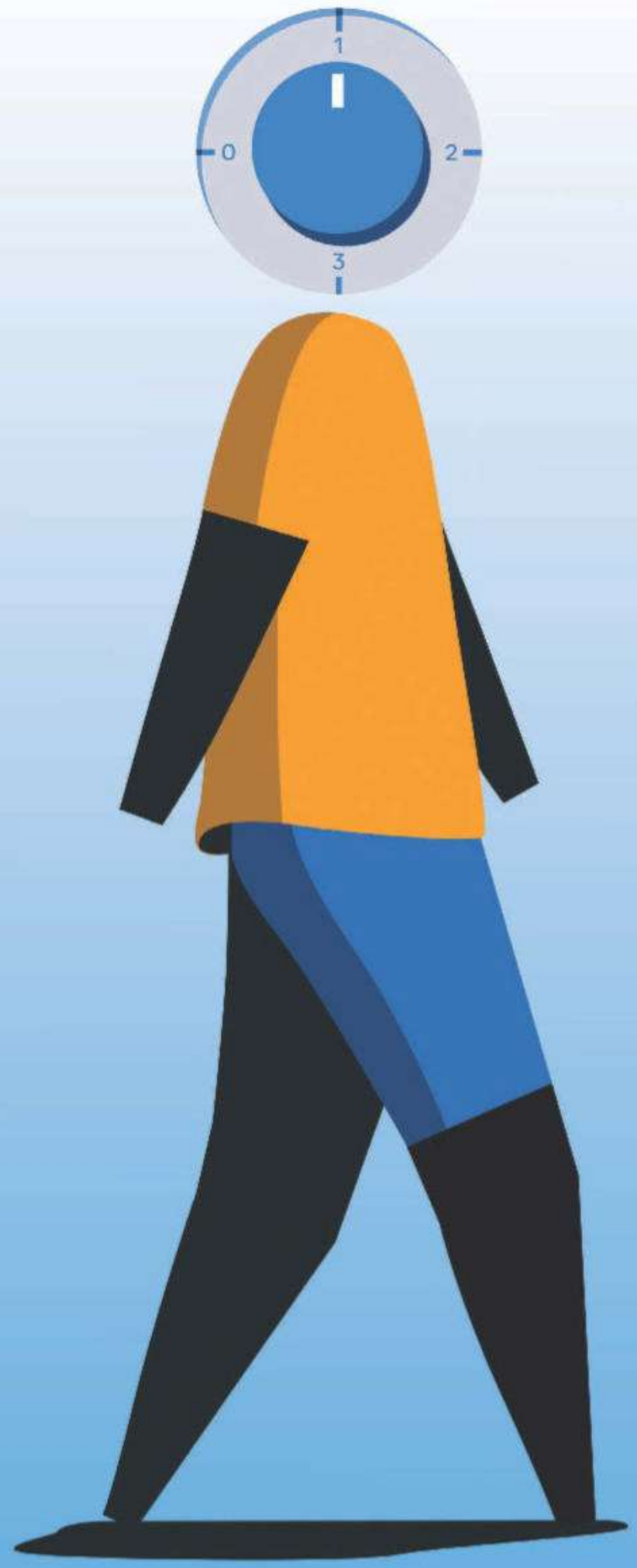
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Tune up your brain

The discovery that a tiny blue blob of neurons controls your mode of thinking suggests ways to increase focus, creativity and more, finds **David Robson**

PLACE a finger on the back of your skull, at a point roughly level with the tops of your ears. Here, deep beneath the hair, skin and bone, near a fluid-filled cavity in the root of your brain, lies a small bundle of pigmented cells the colour of lapis lazuli. This is the locus coeruleus – Latin for "blue dot". It measures just a few millimetres, but its diminutive size belies its power over your thoughts.

Research has revealed that the structure is instrumental in coordinating our mental processing. Sometimes labelled the brain's "master switch", it is perhaps better imagined as a gearbox. "It can set the pace of your brain to suit the specific kind of mental work you are doing," says neuroscience researcher turned writer Mithu Storoni. When it is in the right gear, we feel pleasantly engaged in the task at hand. Often, however, it can get stuck in the wrong one, leading either to dreamy procrastination or frenzied frustration.

Until recently, we knew very little about the ways to control these transitions, but that is changing. It turns out that the brain's little blue dot may be trainable – with immediate consequences for cognition and mental well-being. This means that, with the right techniques, you can change gears, influencing your mental state, from how well you focus and the levels of stress you feel, to your ability to make creative leaps and think on your feet.

A fair appreciation of the locus coeruleus has taken nearly two and a half centuries to emerge. The structure, which contains only up to 50,000 neurons, was first identified by Marie Antoinette's physician Félix Vicq d'Azyr in the late 18th century, after he noted a small blue stain in the brainstem, the mass of neural tissue joining the cerebrum to the spinal cord. Exactly what this little blue dot did, however, remained an unexplored mystery until well into the 20th century, even after Japanese researchers in the 1940s observed in monkeys that damage to this structure results in a loss of consciousness.

Subsequent experiments revealed that the power of the locus coeruleus is intimately tied to its distinctive appearance. It is the brain's primary producer of a neurotransmitter called noradrenaline, or norepinephrine, which it stores in blue-tinged bundles. When a cell within the locus coeruleus becomes active, it releases those bundles along its projections to other neurons within the brain, where the noradrenaline modulates their electrical activity in response to signals from other cells. "It makes it more likely that a cell will 'spike' when it gets the next input, and it makes any spike more forceful and impactful," says James "Mac" Shine at the University of Sydney, Australia. In other words, cells become more reactive, and the result is enhanced communication. "You're making it much easier for a message to be passed [between brain regions]," he says.

This directly affects our alertness – or arousal, as scientists sometimes put it. "Noradrenaline is one of the most important determinants of arousal," says Storoni. Nevertheless, for a long time, the full power of the locus coeruleus went unrecognised. It was thought to be a switch that flips on when we are stressed or frightened – triggering a fight-or-flight response – but that does little at other times. This view partly arose because experiments struggled to measure subtle fluctuations in its activity. We now have much better means of capturing those nuances.

Today, sophisticated brain imaging can watch the blue dot in action, a feat that was once impossible due to its size and location. More often, however, proxy measures are used to monitor the area's activity. The locus coeruleus is directly connected to changes in the pupils of our eyes: the busier it becomes, the wider they dilate. Tracking these movements while keeping light levels constant therefore offers a window on its activity. Microscopic investigations, meanwhile, have shown that the dot isn't a uniform structure as was once thought. "There is much more anatomical specificity," says Susan Sara at the College of France in Paris, which might help explain how it coordinates different patterns of brain activity.

This research has now reached a critical mass, with multiple scientific papers calling for a greater appreciation of the locus coeruleus. Of particular interest is the discovery that it has four different modes of activity, each with distinct effects on our thinking and behaviour. It is this that led Storoni to describe the blue dot as the brain's "gear system" in her new book *Hyperefficient: Optimise your brain to transform the way you work*.

Bursts of activity

According to this metaphor, Gear 0 is the state of the locus coeruleus when you are asleep. It is almost completely silent at this point, apart from transient bursts of activity that seem to enhance the long-term storage of memories. Sara discovered this effect by chance while working with Oxana Eschenko at the Max Planck Institute for Biological Cybernetics in Tübingen, Germany. They first trained rats to find their way through a maze. Then they recorded the rodents' brain activity as they slept and found that the locus coeruleus fired sporadically around 2 hours after they had completed the task. "This activation seems to be directly correlated with the memory performance that you measure a day later," says Sara. "And if you block it, then you see a memory deficit."

Once we awaken, the locus coeruleus ›

VINCENZO LODIGIANI

New Scientist Live

The laws of social connection

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moves into Gear 1 – a low hum of baseline activity. The noradrenaline eases the brain into consciousness, but it is a state of low arousal. As a result, sharp focus is lacking and we may be prone to mind-wandering.

As levels of noradrenaline increase, communication across the different regions of the brain becomes easier. Neurons in the prefrontal cortex, the area typically associated with self-control and abstract reasoning, respond first because they are sensitive to low levels of noradrenaline. Crucially, the hum of activity in the locus coeruleus is now accompanied by spikes of noradrenaline released in response to relevant stimuli. This combination of moderate baseline activity and short-lived bursts of neurotransmitter release is characteristic of Gear 2 and allows the brain to process new information more efficiently. If they are large enough, these spikes can trigger a "network reset" – a shift in focus to new and important information – which is essential for flexible thinking. "It reorganises the forebrain, precisely at the moment when you need to switch your attention and adapt your behaviour," says Sara.

Problems may arise when the hum turns to a roar. This is what happens in Gear 3. Here, high levels of noradrenaline streaming from the locus coeruleus can activate areas of the brain associated with emotional processing. These tend to have receptors that respond only when concentrations of the neurotransmitter have reached a higher threshold. This can lead to the fight-or-flight response – useful if we are in danger and need to be hyperalert. Unfortunately, many situations that don't involve danger, such as pressure at work, can also put the locus coeruleus into its top gear. We may then feel overwhelmed when what we need is greater focus.

In people with anxiety or post-traumatic stress disorder, the locus coeruleus may become too easily locked into the high-arousal mode of Gear 3. "We know that there is increasing release of norepinephrine, both in wakefulness and sleep, in patients suffering from PTSD," says Sara.

Intriguingly, this gearing mechanism has also been implicated in ADHD. The problem here seems to be that moving too rapidly between gears makes it hard to remain engaged on a task. Existing ADHD medications may work in part by addressing this imbalance. For instance, we know that Ritalin raises the levels of dopamine, a neurotransmitter associated with the brain's reward system. This could increase the sense of reward associated with tasks and, therefore, the attention paid to them.

But Ritalin also keeps the brain's noradrenaline at a more constant level, which could then moderate the activity of the locus coeruleus through a feedback loop. "[The structure] is exquisitely sensitive to the amount of free noradrenaline and, like a thermostat, turns down its firing rate if local noradrenaline concentrations get too high," says Shine. A recent study found that people with ADHD taking Ritalin showed patterns of eye dilation – which indicate, of course, locus coeruleus activation – similar to people without ADHD.

Given these findings, many neuroscientists now consider moderate locus coeruleus activity – that is, Gear 2 – to be key to optimum cognitive performance, a sweet spot between dreamy and frantic. "It's when the prefrontal cortex is completely engaged and working at its best," says Storoni.

Further evidence supports this view. In 2016, for instance, scientists at Leiden University in the Netherlands tested the attention of participants with a series of quickly morphing images showing either cities or mountains. The volunteers had to press the space bar when they saw the urban landscapes and release it when they saw the rocky summits. As they performed the task, an eye-tracking machine measured their pupil dilation. Sure enough, the most accurate performance occurred when the pupils indicated the moderate locus coeruleus activity characteristic of Gear 2. Other studies indicate that this increased concentration helps us hold more information in our short-term memory – an essential ability for any complicated mental task.

Shifting to Gear 2 also seems to enhance the chance of "convergent creativity", which entails a flash of insight or an aha! moment. Previous research has shown that giving people a tight deadline can accelerate the solution of easier puzzles, whereas the exact opposite is true for harder puzzles. The reason was once unclear, but David Beversdorf at the University of Missouri, who analysed

JOHN MACLEAN/MILLENNIUM IMAGES

When you are asleep, your brain's locus coeruleus is in **Gear 0**, an inactive state...

NINA MANGALANAYAGAM/MILLENNIUM IMAGES

...as you wake up, the locus coeruleus moves into **Gear 1**, a gentle hum of activity where your concentration is low...

HEINER HEINE/IMAGEBROKER.COM GMBH & CO. KG/ALAMY

...working on moderately difficult tasks can push the locus coeruleus into **Gear 2,** which enhances focused and flexible thinking...

ALI BALLI/ANADOLU AGENCY VIA GETTY IMAGES

...but if we are too challenged and become stressed, the locus coeruleus slips into **Gear 3**, which readies us for a fight-or flight response.

studies of convergent creativity, suggests the blue dot holds the answer. With the easier problems, he says, the extra pressure may gently raise its activity from a low baseline to its optimum point. As the task difficulty increases, however, anxiety about meeting the deadline puts the locus coeruleus into overdrive, resulting in foggier thinking. "As soon as you start worrying too much, you tip into Gear 3," says Storoni.

Recent research even suggests that Gear 2 underpins the famous "flow state" – the feeling of being so totally engaged in a task that you forget the passing of time. "People find flow rewarding," says Dimitri van der Linden at Erasmus University Rotterdam in the Netherlands. "They can spend hours on the same activity." To work out whether this depends on the locus coeruleus, he and his colleagues presented people with a tricky computer game in which they had to recall a sequence of alien creatures that continued popping up on the screen while the team measured fluctuations in pupil diameter and brain activity. Sure enough, participants' feelings of flow corresponded with activity of the locus coeruleus: they were more likely to endorse the statement "I was 'in the zone'" when they showed signs of sliding into Gear 2.

Flow occurs when you engage in an activity that is just challenging enough for you. So choosing the right task difficulty may be one way to change mental gears and harness the power of the locus coeruleus. Shine also points to evidence that practices like meditation can enhance overall focus and emotional regulation. "I think of it as a way of training the arousal system – which the locus coeruleus is a part of – so that you have much more conscious control in everyday life," he says.

Finding your flow

Another strategy is to make the most of the mind-body connection. Storoni says the locus coeruleus has a direct relationship with the autonomic nervous system, which regulates things like our heart rate and breathing. This means physical movement can influence its gearing. For instance, light exercise – such as a brisk walk – in the early morning can move us from Gear 1 to Gear 2. To wind down from Gear 3, meanwhile, we might engage in yoga and controlled breathing.

In her book, Storoni suggests that we listen to our circadian rhythms, too, and plan our activities around the natural changes in arousal. Those tasks that require creativity may be best suited to the start of the day, when we are easing into Gear 2 and can combine associative and analytical thinking. More focused work that involves intense information processing is better left until later in the morning, when we are firmly in Gear 2, or around 3 or 4pm, when most people return to peak focus after a mid-day dip in arousal.

We might also reconsider the way we manage our work. Monotonous or boring tasks can shift us down into Gear 1, for example, so that we lose focus and begin daydreaming. Here, the solution involves increasing mental load. "Perhaps by doing something in parallel, a form of multitasking," says Storoni. Listening to music is one option, but sometimes you may need something that requires more concentration, such as an audiobook. With intense work, we face the opposite problem: the brain can only spend so much time in Gear 2 before it starts feeling fatigue. That's why we should arrange regular breaks.

In the future, new tech could increase our ability to train our locus coeruleus. Storoni points to a series of recent experiments that provided participants with real-time feedback about their pupil dilation, presented as a circle on a computer screen. Before they started the experiment, they were encouraged to think of scenes that might raise or lower their feelings of mental alertness. One participant chose to imagine jumping from a cliff into the sea to increase their arousal, and pictured floating peacefully in the air to reduce it. The training worked: over three daily sessions, the participants had better control over their locus coeruleus, a fact confirmed by a functional MRI scan that directly measured its activity.

You may have to wait a while until such equipment becomes widely available. But simply knowing about your brain's gears can make a difference. The key is self awareness: noting when your brain is under- or overstimulated and adapting your behaviour appropriately. It may have taken more than two centuries, but it is time we all learned to respect our little blue dot. ▮

David Robson's latest book is *The Laws of Connection: 13 social strategies that will transform your life*

How the Neanderthals really died

Secrets in the genome of one of the last Neanderthals are overturning everything we thought we knew about the extinction of our closest cousins. **Alison George** reports

SIMON PRADES

AROUND 41,000 years ago, the very last Neanderthal took their final breath. At that moment, we became the only remaining hominins, the sole survivors of the once diverse family of bipedal apes.

We will never know exactly when or where this momentous event took place, but we do know the Neanderthals died out suspiciously close to the time when modern humans arrived in their territory. Exactly why they vanished has long been hotly debated, but astonishing revelations from the genomes of the last Neanderthals and hidden in a remarkable cave in France are now painting a detailed picture of these first encounters – and what might have happened next.

"This is a major turning point in our understanding of Neanderthals and their extinction process," says Ludovic Slimak at the Centre for Anthropobiology and Genomics of Toulouse, France.

Our species, *Homo sapiens*, and Neanderthals share a common ancestor,

but Neanderthals split from our lineage at least 400,000 years ago, evolving in Eurasia, from the Mediterranean to Siberia. Our species is younger, first appearing in Africa some 300,000 years ago and evolving into hominins that were anatomically much like us by at least 195,000 years ago. Modern humans left the continent in waves from around 170,000 years ago, and were thought to have reached western Europe roughly 43,000 years ago, when – according to the well-established view – they replaced the Neanderthals within just a few thousand years.

There are clear differences in the appearance of the two species. Neanderthals were shorter and stockier than us, with wider ribcages and pelvises, and their faces had pronounced brow ridges. Once regarded as brutish, unintelligent thugs, their reputation has been completely overhauled in recent decades, as evidence emerged that Neanderthals were skilled tool-makers who buried their dead, may have drawn on cave walls and invented complex substances such as birch tar, which was used as a glue, among other things. According to this new view, they weren't all that different from us.

So why did they die out while modern humans conquered the world? Numerous explanations have been put forward, including climate chaos unleashed by the flipping of Earth's magnetic field or a massive volcanic eruption. The success of *H. sapiens,* however, complicates any hypothesis involving such epic catastrophes – because why would modern humans have been unaffected?

Another popular idea is that Neanderthals were actually killed off by the incoming modern humans, whether deliberately or accidentally through the introduction of diseases, or that they were unable to compete with modern humans for resources. Still others argue that the Neanderthals didn't really die out, but were instead assimilated into our lineage through interbreeding. It is certainly true that 1 to 4 per cent of the genomes of people today with non-African ancestry are derived from Neanderthals.

What would help clear things up is hard evidence of what happened when the two species encountered each other. And, unbelievably, archaeologists have found it – in a cave in France.

Grotte Mandrin is a hillside rock shelter that overlooks the Rhone river valley in south-east France, along an important wildlife corridor linking the Mediterranean to northern Europe. For more than 80,000 years, this place has been a valuable location to hominins, commanding excellent views of herds of animals (although today it overlooks a busy motorway and railway line). Excavations in the cave began in 1990 – and what Slimak and his colleagues have found since is rewriting what we know about when modern humans arrived in Europe and their interactions with the resident Neanderthals. "The site of Grotte Mandrin keeps delivering surprises," says Chris Stringer at the Natural History Museum in London.

From the stone tools and other artefacts left in the layers of sediment on the cave floor, we know that Neanderthals began using this shelter about 80,000 years ago and continued to visit periodically until the time of their extinction. But the archaeological excavations uncovered some unexpected things in the dirt.

The first surprise came in the 1990s, when 1500 tiny, triangular stone points resembling arrowheads were unearthed in a layer of sediment in the cave floor dating from 52,000 to 57,000 years ago. These were unlike any Neanderthal artefacts discovered in other layers in the cave – but they were almost identical to artefacts left by modern humans in roughly the same time period at a site called Ksar Akil in Lebanon, nearly 3000 kilometres away. Then, in 2018, a tooth belonging to a *H. sapiens* child was found in the same strata, sandwiched between layers of evidence of Neanderthal habitation.

Together, these findings demonstrated that modern humans had reached Mediterranean France around 54,000 years ago, a staggering 10,000 years earlier than had been thought. This was "massive news because it placed our species in western Europe well before the 'red line' of around 40 to 42,000 years ago which data up to then seemed to suggest was the upper limit for their presence", says Rebecca Wragg Sykes at the University of Cambridge.

Grotte Mandrin was first visited by Neanderthals, then modern humans for ›

a period of one, possibly two generations. A millennium or two later, the Neanderthals returned, only to be again replaced by modern humans. This kind of occupation sequence hasn't been found elsewhere and it complicates the idea of a simple population replacement to explain the Neanderthals' disappearance. "Mandrin is unique in that it's the only site really where we have any evidence that the Neanderthals return," says Wragg Sykes.

Equally astonishing is that Grotte Mandrin also offers a fine-scale view of these comings and goings, thanks to a technique pioneered by a member of Slimak's team, Ségolène Vandevelde at the University of Paris, Panthéon-Sorbonne. When cave visitors lit fires, the smoke coated the walls and ceiling with soot. During periods when the cave was unoccupied, a layer of calcium carbonate would have formed over the soot, in as little as two months. This process happened repeatedly, resulting in alternating black-and-white crusts on the cave surfaces that, under the microscope, resemble a barcode, each stripe representing a different visitation.

Fragments of this crust broke off and became buried in the sediment layers on the cave floor. With the soot fragments as evidence of visitation, the sedimentary layer could then provide dating. Artefacts found in the layers completed the picture, allowing archaeologists to determine who was visiting the shelter when, over a period of 80,000 years.

Together, the evidence suggested that there was a maximum of a year between the first modern human fire in the cave, some 54,000 years ago, and the preceding fire lit by Neanderthals – providing conclusive proof that these two hominins were in the same area at the same time.

"The two groups... share this territory," says Slimak. "In that moment, the question is, what was the interaction with the local Neanderthals?" Slimak thinks that the two species cooperated, pointing to evidence that the incoming modern humans used the same flint for their tools as the local Neanderthals, some from sites as far as 95 kilometres away. "It's likely that there must have been good relations, with shared territories and shared knowledge," he says.

What happened next is complex. After the first band of modern humans departed, 54,000 years ago, it took 1000 to 2000 years for Neanderthals to return to Grotte Mandrin. This group used the cave for the following 12,000 years, but when the next group of modern humans moved in, all traces of the Neanderthals disappear – not just from this cave, but from all over Europe, with the possible exception of some areas in the far north and south. So why did this encounter coincide with the disappearance of the Neanderthals, when they were able to survive for 12,000 years after their first meeting with *H. sapiens*?

"Humans don't die in 'bim-bam-booms', they die in whispers"

Here, too, Grotte Mandrin is offering some answers. In 2015, Slimak cleared away some dead leaves from outside the cave and spotted some teeth in the ground. They turned out to belong to a Neanderthal. "That was absolutely surprising," he says.

A painstaking excavation began, removing the sediment grain by grain with tweezers to preserve every bit of information. Thus far, the team has found 31 teeth, along with fragments of a skull, hand and other bones, all from the same individual.

Slimak called the Neanderthal fossil Thorin, after the Dwarf king of J. R. R. Tolkien's *The Hobbit*. He sent a fragment from one of Thorin's teeth for DNA analysis, but wasn't optimistic: DNA isn't typically preserved in warm climates and previous attempts to obtain genetic material from the site

LUDOVIC SLIMAK

SÉGOLÈNE VANDEVELDE ET AL. (2017)

Grotte Mandrin in France from a distance (below), and soot deposits inside the cave that record human visits (bottom)

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were unsuccessful. This time, however, the researchers struck gold.

The genomic analysis revealed that Thorin was male; analysis of the isotopes in his bones and the sediment surrounding him indicated that he had lived sometime between 42,000 and 45,000 years ago – making him "one of the very last Neanderthals", says Slimak. But though dating incontrovertibly made Thorin a late Neanderthal, his genome didn't match those of any of his species who lived at the same time. "Thorin was completely divergent," says Slimak.

In fact, Thorin's genome appeared similar to those of far more ancient Neanderthals, from around 105,000 years ago. Researchers struggled to make sense of this puzzle for years, before realising that Thorin was descended from a previously unknown lineage, a remnant of an ancient population that had diverged from the main Neanderthal population some 105,000 years ago and remained in extreme isolation, living in small groups, for more than 50,000 years.

"There is no integration between 'classic' Neanderthals and Thorin's population," says Slimak. "It's no longer just a question of Neanderthals and *Homo sapiens*, it's a question of different populations of Neanderthals, very distinct, very isolated."

Dying in isolation

Analysis of Thorin, coupled with revisiting the genome of another late Neanderthal who lived around 43,000 years ago in what is now central France, indicated to Slimak and his team that there was at least one, or more likely two, previously unknown groups of isolated Neanderthals that persisted right up to the end of the species.

These insights into Thorin's population also fit with discoveries about the social structure of other Neanderthal groups. A 2022 study that analysed the genomes of 13 Neanderthals who lived between 44,000 and 59,000 years ago from two sites in the Altai mountains in Siberia found high levels of homozygosity – inheriting identical genes from both parents, or inbreeding – indicating that they probably lived and reproduced in small groups of about 20 individuals at a time and had little interaction with outsiders. "Overall, this fits with the wider picture that late Neanderthals were, in general, not very interconnected with each other," says Wragg Sykes.

But why? Slimak suspects that the first incursion by modern humans, though short, had a destabilising effect on Neanderthal populations, noting that the Neanderthals

LUDOVIC SLIMAK

Excavations at the entrance of Grotte Mandrin

at Grotte Mandrin initially shared their territory and sources of materials with the modern humans – but then stopped. "After the incursion of *Homo sapiens* into that territory, this population begins to live in very fragmented territories, with no exchanges with other populations," he says.

The lack of interchange between Neanderthal groups across Europe had implications for the survival of the species, not least because the associated inbreeding could have degraded the genetic fitness of the population. This isolation would also mean that Neanderthals didn't benefit from sharing ideas. At Grotte Mandrin, the effect of this social isolation is reflected in the artefacts found at the site. The few stone weapons lifted from the sediment layer of Thorin's lineage are large and rather clumsy triangular shapes, quite unlike the artefacts found at other Neanderthal sites from the same time.

They stand in even starker contrast to the tiny, arrowhead-like objects seen in the modern human layers from before and after Thorin's time, which, if used as projectiles, would have enabled the much safer hunting strategy of killing animals at a distance. This sophisticated weaponry seems to have arisen through modern humans sharing information via a vast social network – after all, arrowheads of precisely the same design were found in Lebanon. "That means that there are... very important networks that are used by this population to keep contact," says Slimak. "The social network is very strong and very large." He argues that this standardisation of tool-making techniques made modern humans more efficient; their vast social networks allowed them to spread their best practices, giving *H. sapiens* an advantage over Neanderthals operating in isolation. "This efficiency acts like a wave, and all the other past humans have been taken by this wave," says Slimak.

Yet despite the deep isolation of some late Neanderthal groups, they still sometimes interbred with modern humans. What is curious, however, is that though Neanderthal DNA appears in *H. sapiens* fossils, there is no sign of modern human DNA in any late-surviving Neanderthals sequenced so far. "We know that these groups overlap for thousands of years in Europe, yet we find this largely one-directional gene flow from the Neanderthals to modern humans and not the other way around," says Mateja Hajdinjak at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany.

There are many possible explanations for this one-sided genetic exchange. It could simply be due to sparsity of data, as relatively few Neanderthal genomes have been sequenced. Alternatively, Neanderthal DNA may have been more important for the survival of modern humans than the other way round – for example, bolstering immune system function – so was preserved in later generations by natural selection.

Or, says Hajdinjak, "it could be social practices" that resulted in babies born through interbreeding being kept in modern human groups but not Neanderthal ones. Slimak suspects that Neanderthal women were joining the modern human groups, but the reverse didn't happen.

"Their already small populations were losing reproductive age individuals to the other species, without any replenishment in return – a recipe for demographic disaster," says Stringer. Whatever the reasons for the genetic imbalance – social, biological or both – it contributed to the demise of the last Neanderthals, he says.

It all suggests that the end of the Neanderthals was a long, messy process. Looking for a single catastrophic explanation for Neanderthal extinction, such as a volcanic explosion, is wrong, says Slimak. "Humans don't die in 'bim-bam-booms'... they die in whispers." ▮

Alison George is a features editor at *New Scientist*

"We have to embrace the fact that we make reality"

Theoretical physicist **Daniele Oriti** argues that the laws of nature don't exist independently of us. He tells Thomas Lewton what this means for our understanding of reality

MOST physicists operate under the assumption that there is a world out there that is entirely independent of us, an objective reality in which more-or-less well-defined things behave according to immutable physical laws. Yet over the past century, ever since the development of quantum theory, there have been discombobulating questions about the role of observers – not least ourselves – in the makings of reality.

These questions are often brushed under the carpet, but Daniele Oriti, a theorist at the Complutense University of Madrid, prefers to confront them. Arguably, he has been pushed to do so by his work on one of the foremost challenges in modern physics: creating a quantum theory of gravity. The difficulty here is reconciling the inherently smooth picture of space-time in general relativity with quantum theory, which is written in contradictory mathematical language. Getting the two to play nicely together has forced Oriti to think deeply about the subtleties of physical laws – not least the fact that space-time is a shaky foundation on which to build them. His verdict? That physical laws can't exist independently of us, as something that we can all agree on, but instead reside within us somehow.

MARTA ZAFRA

Oriti spoke to *New Scientist* about how he came to such a startling conclusion, why physicists need to be more aware of the complex relations between the world, scientific models and observers, and how appreciating the true nature of physical laws might yield fresh breakthroughs.

Thomas Lewton: What do people get wrong about the nature of reality?
Daniele Oriti: At the risk of seeming provocative, most scientists – and anybody who hasn't really thought about the issue – maintain a position that philosophers call "naive realism". This is the idea that there is a world out there that is entirely independent from us, not just in its existence but also in its properties: independent from the minds apprehending it, or from our theories about it. It's made of things that are similarly independently defined, with intrinsic properties, which follow patterns that are also independent of us – even if we may not know about them.

I have been guilty of that position too. As a physics student, you want to understand the world. You build models, you revise them and you think that you are getting closer to the actual story. That's the picture, and it's very naive.

Why is that kind of thinking so naive?
First of all, it is naive on conceptual, philosophical grounds. But I would also say that modern science, particularly quantum mechanics, blurs this picture. One of the main lessons of quantum mechanics is that the distinction between us and the world isn't really there, not sharply anyway. It tells us the properties of a particle are encoded in a probabilistic entity we call a wave function, which tells us the likelihood of it appearing here or there, for instance – but that the particle cannot be attributed definite properties until it is observed. It's screaming at us that observers really matter.

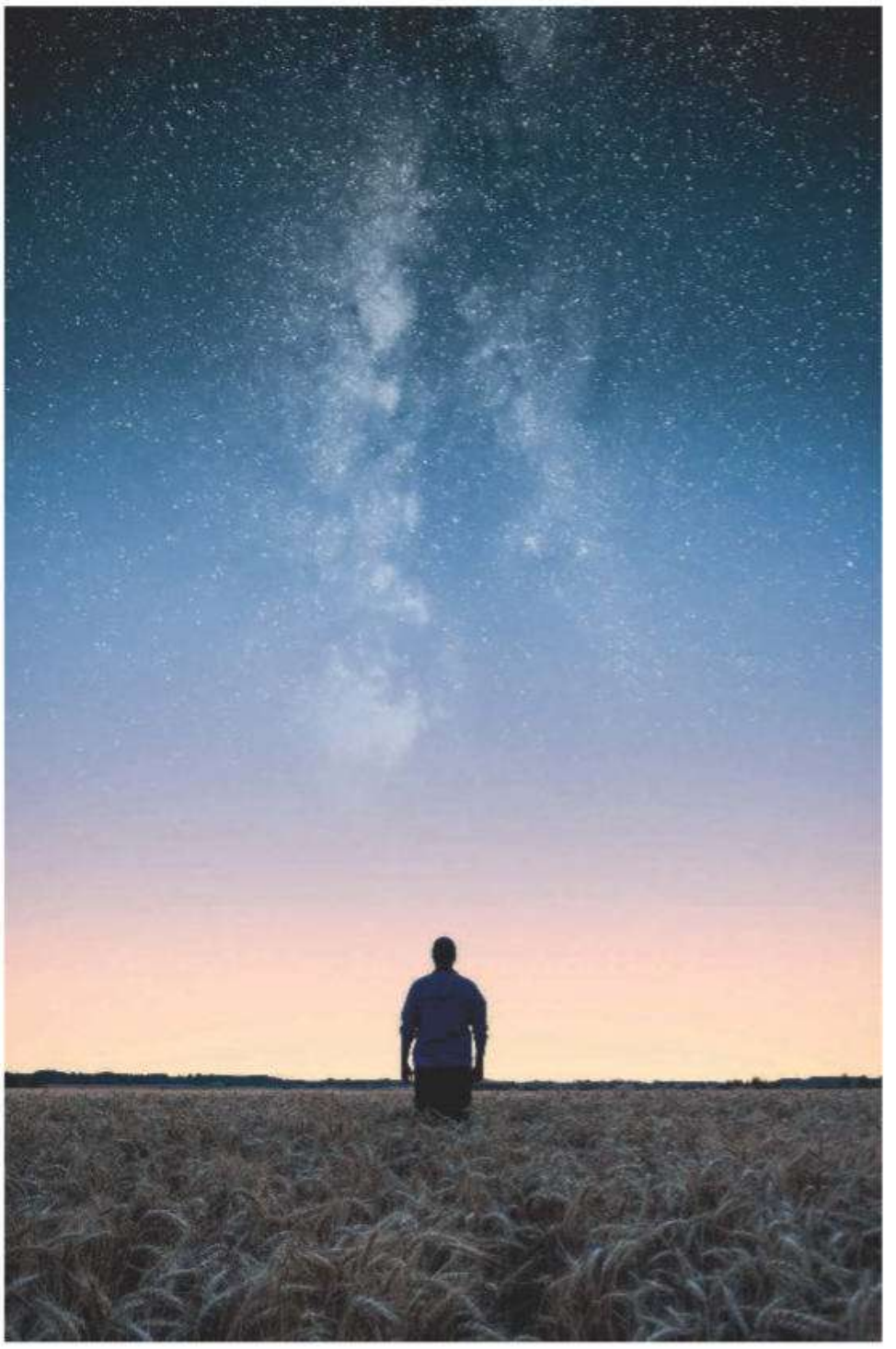
How should we think about these observers?
There are many different interpretations of these experimental findings from quantum mechanics, which can be divided into two broad classes. In one set of interpretations, the quantum state, or the wave function, is "ontic", meaning it is a real property, such as a particle's position or velocity. In these interpretations, one can maintain the simple notion of realism, and just add quantum states to the intrinsic properties of systems.

Another class of interpretation says that the wave function isn't a property of the system ›

being studied, but rather a property that the observer – a second system – attributes to it. It is a way of accounting for the knowledge or the belief that the second system has about the first. In this case, the wave function is said to be "epistemic".

Some physicists take this epistemic route, but maintain that there is still some hidden reality of the standard kind, it is just that quantum states do not capture it. However, a number of epistemic interpretations suggest something more radical: there is no hidden reality. This means that quantum states are all there is and reality can only be defined in the relations between observers and what they observe.

Perhaps the most extreme example is QBism, which holds that the wave function is merely a tool we use to organise our uncertainty about the world. But there are other interpretations, like relational quantum mechanics, which says that the core of reality lies not in objects themselves, but in their interactions.



JARMO PIIRONEN/ALAMY

In quantum mechanics, observers can't be fully separated from wider reality

How has your research into quantum gravity changed how you think about physical laws?
It has made it more complicated to characterise what laws are, even assuming they are somehow "out there", independently of us.

One basic philosophical notion of laws starts with the idea that there are facts out there in the world and there are patterns among these facts. Physical laws go beyond patterns, they are said to "supervene" on facts – but both facts and laws are considered real.

The problem is that space and time are crucial for first identifying and then gluing together these facts about the world. If you check the main proposals for what laws are from philosophers, they all rely on space and time to some extent. But quantum gravity strongly suggests space and time are not actually fundamental. Instead, we suppose that space-time emerges only in some approximation, rather than being built in at the fundamental level. How does that impact our understanding of laws? Well, we have to replace space and time with an alternative grounding for laws.

What do you mean when you say that space-time emerges?
We don't yet have a working theory of quantum gravity, but every approach so far tells us that classical space-time – which functions as a gravitational field and is smooth and has a definite geometry – is not going to be there. That's because the minimal step we have to take is to turn these classical fields into quantum fields, which means they have quantum properties, like superpositions and quantum fluctuations and so on. So already, you cannot rely on a space-time with a clear geometry and causal properties. Some approaches to quantum gravity go further and replace the classical fields with something else.

What could replace something as seemingly fundamental as space and time?
Modern approaches to quantum gravity say that space-time emerges from something deeper – and this could offer a new foundation for physical laws. These approaches suggest that space-time in general relativity isn't just replaced by quantum fields, but they are themselves approximate notions to something that is more fundamental – some other conceptual ingredients that we are yet to identify. They're suggesting that there is a microstructure beneath space-time.

What would this microstructure be like?
I work with quantum gravity models in which you don't start with a space-time geometry, but from more abstract "atomic" objects described in purely mathematical language. I treat the universe as a peculiar quantum system made out of these building blocks and I apply techniques and concepts from condensed matter physics, which is typically concerned with liquids and solid matter. If you think of the universe like this, as if it were a strange kind of fluid, you can show that its usual space-time description can emerge in the coarsest approximation from those non-material microscopic "atoms".

We may also need another ingredient in order to make this foundation solid enough to support laws of nature. One possibility here is that a key role is played by quantum entanglement, which is a subtle connection between two quantum objects. There is a suggestion that the classical geometry of space-time can be traded for the relations between those entangled "atoms" of space-time. There are interesting theoretical

results where people relate measures of entanglement to the geometric properties of the same systems. For example, you compute the degree of entanglement between two separate quantum systems across a range of distances and you find that it scales with the distance. Then people reverse the usual thinking and say, well, instead of distance defining entanglement, perhaps the amount of entanglement defines the distance. That can provide a primitive notion of relations in space because it can be applied before the usual space-time emerges.

But if we can find an alternative background on which to build laws, doesn't this mean that physical laws do exist after all?
Yes, these approaches to quantum gravity have been developed without questioning the reality of laws. And they help us to keep some of the traditional, ontic view of physical laws. As for me, though, I'm still inclined to think that physical laws are really epistemic in nature, so something that exists primarily in our minds.

That's because, from a philosophical standpoint, what we identify as a "law of nature" always has some component of our models of the world, selected because of some epistemic virtue we favour. The further claim that the law is somehow "out there" seems gratuitous to me. And, as I've already said, I think quantum mechanics challenges the idea of a separation between the "world" and "us".

> "The notion of objective laws is like the scientific version of God"

How do we reconcile our model of reality with those of other observers, like cats?

SOPHIECAT/SHUTTERSTOCK

So what would reality look like without any physical laws?
The picture I have in mind is like an infinitely complex, amorphous reality to which we give shape and meaning by virtue of the models we construct. In a sense, models and laws are in our head, but there isn't such a sharp distinction between our thoughts and reality. Reality is made by our models, not just described by them. The models we create, the concepts, mathematics and language we use – these all depend on our interactions with the world, our cognitive structures, our history. The same is true in broad terms for any agent making sense of the external world. My cat, for example.

Your cat?
Of course, his cognitive structures and sensory experiences are different, as is the way he makes sense of observations. So the models of reality he constructs are not like mine. Therefore, from an epistemic perspective, the laws of nature, according to him, are different.

What are we supposed to do then, if cats and people and other agents, whatever they are, have differing perceptions of reality?
In the naive realist picture, that is totally trivial: there is just the world out there and models that get closer to it. But the moment we add the complex relations between models and the world, and we realise that what is real is somehow at the interface between the two, then it's much less trivial.

The key issue – and it's difficult – is to reflect upon the relations between the different, equally valid perspectives of different epistemic agents. What makes their perspectives somehow coherent with one another? Well, we communicate. We aren't just epistemic agents, but also social epistemic agents. Social agents construct a world that is dependent on the interactions between agents. The best models in science are not out of the blue or simply dictated by nature. They are agreed upon by the community of epistemic agents we call scientists, considering all the other constraints coming from observations, logic and so on.

What does this mean for the idea of there being an objective world out there?
It means that the strongest possible form of objectivity is naive. So what is true or false, what is real or not, cannot be perspective-independent. The best we can hope for is that there is a way to translate from the one perspective to another, and that, for any two observers, the translation doesn't leave anything behind.

So it's not that we necessarily agree on everything. But I can perfectly translate from my perspective to yours. I can put myself in your shoes and know precisely and comprehensively what you see of the universe. I have to confess that I'm not even convinced that this is actually something that we can achieve exactly.

How does all this change our conception of what a physical theory is in relation to reality?
It forces us to think more seriously about the relation between our theories and reality. And it suggests a direction for research in which we revise what we mean by what is real, where these epistemic components are far more relevant. To a certain extent, it also gives us much more responsibility. The notion of objective, exact laws governing the world is the scientific version of God. Without it, we are like a ship in a storm; we have to navigate this world alone.

In the old notion of reality, we have no responsibility for what things are – we just happen to be here, we don't participate in the world. I would say that the epistemic perspective forces a more participatory understanding of what is real, with many more philosophical responsibilities as scientists to reflect on what we do. But it's also much more exciting, because we are not just witnessing something we have no role in. We have to embrace the fact that we make reality. ▮

Thomas Lewton is a features editor at *New Scientist*

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Stargazing at home

Ringed with ice

My first sight of Saturn through a telescope inspired my love of space. Now is a great time to see our sixth planet, says **Leah Crane**

Leah Crane is a features editor at *New Scientist* based in Chicago

WHEN I was a teen, I joined an urban astronomy club at my school. It wasn't popular: most nights, it was just me and a physics teacher standing on a Chicago street corner haranguing passersby to look through our telescope. In hindsight, it is a wonder my parents agreed to this, but it was one of the first things that really fed my love of space.

One night, another teacher joined us. He brought along an old-fashioned refractor telescope, the long kind. It looked much more impressive than our usual small telescope, so a crowd gathered as he pointed it at Saturn. This month, like that one, is an excellent time to see this planet in the sky, which is why I am telling you this story.

When you view Saturn through a telescope, your first instinct will be that it can't be real. Someone must have slapped a sticker on the lens as a prank, because Saturn can't possibly look like that from billions of kilometres away. When I peered through that old-fashioned telescope, I saw a perfect, crisp outline of a planet encircled by a thick band of rings. There was even a visible gap between the rings and the planet. It made Saturn feel real in a way that it never had been before.

I almost think that, up close, Saturn would feel less real than it does from here. From Earth, its rings look like a solid block of material, but in reality they are made of countless tiny particles hurtling around the

GREY ZONE/ALAMY

planet in concert, almost entirely made of water ice. They are less than a kilometre thick, which is wild when you consider that Saturn is about 120,000 kilometres across, nearly 10 times wider than Earth. And they aren't a single disc like a CD, but rather a series of nested bands with gaps between them, often shepherded by small moons that act a bit like cosmic robot vacuum cleaners as they orbit through the rings.

Of course, you can't see all that from Earth, but Saturn astonished teenage me, and maybe it will astonish you too. In October and November, Saturn will be visible just after sunset, in the south-eastern sky across from the setting sun in the northern hemisphere. It will rise through the southern sky and then set in the west in the wee hours of the morning. You can see it in the southern hemisphere too, looking north-west.

With the naked eye, Saturn will just look like a dot. But if you have a decent telescope, or if there is an astronomy club in your area, you might see the clear outline of the rings. Maybe it will inspire you to love space just like it inspired me.

Now that I think about it, this column is a bit like my school club, except I am writing instead of shouting "Hey, who wants to look at Saturn?" on a street corner. I will be taking over this column for around a year, so I'll be back next month to yell at you about space some more! I can't wait. ▮

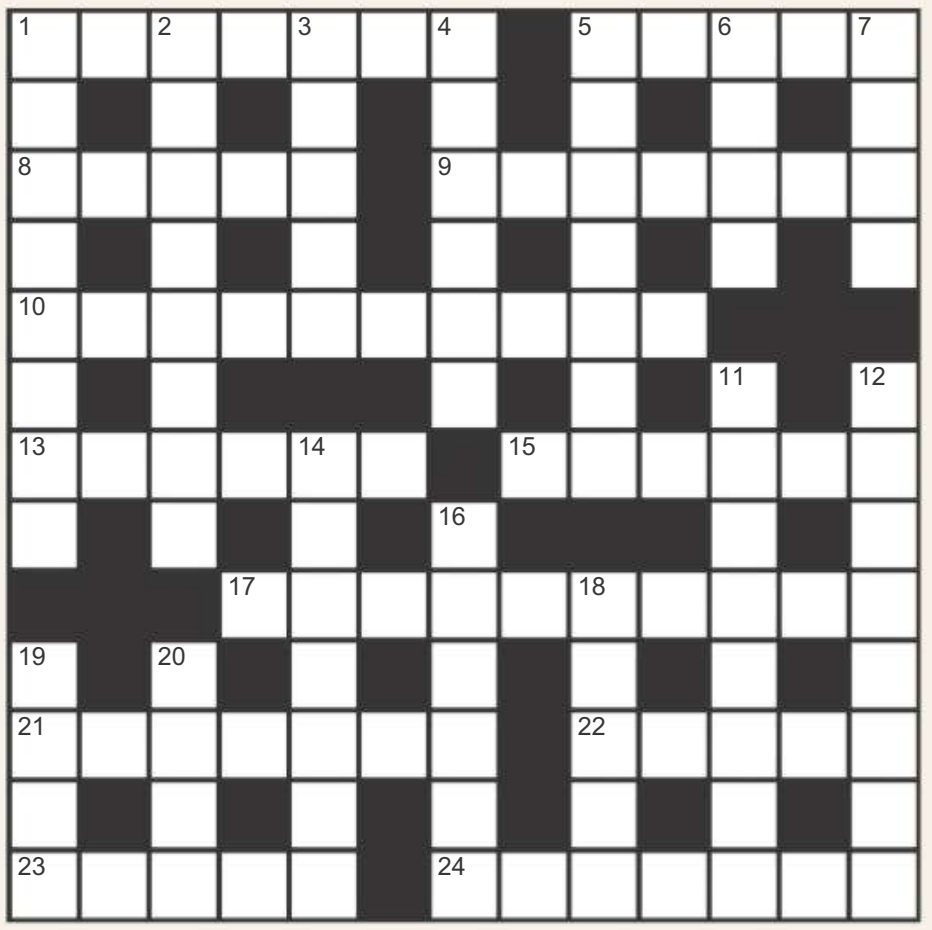
Share your stargazing successes with us on X and Instagram @newscientist using the hashtag #NewScientistStargazing

These articles are posted each week at newscientist.com/maker

Next week

Mathematics of life

Cryptic crossword #146 *Set by Rasa*



Scribble zone

Answers and the next quick crossword next week

ACROSS

1 Gimme authentic, drug-free rock (7)
5 Doctor Mike iced wound (5)
8 Run parts through film-maker's helper (5)
9 "Free ale," Huns snarled (7)
10 Develop penal code's small adjustment (4,6)
13 State of Pennsylvania accepting Los Angeles's millions (6)
15 Catch spouse returning before the finale (6)
17 Refiling an irregular talon (10)
21 Rodeo horse briefly hit unfinished air conduits (7)
22 Rubbish page by playwright (5)
23 Krypton's neighbour revolving zero times (5)
24 Fast talk without purpose (7)

DOWN

1 They stop splattering flood maps, per Spooner (8)
2 Very bright couples with a short story for infants (8)
3 Smells vegetables changing hands (5)
4 Throw bit of asparagus into meal (6)
5 Touch of maroon flair in pigment (7)
6 Sketch hospital wing from the south (4)
7 Boardroom bigwig eats hot salmon (4)
11 Was sore after buddy is raised for discussion (8)
12 Tablet framed by rock component of a dam (8)
14 Diagnostic test is let go after mass resistance (3,4)
16 Less appealing gruel mixed with iodine (6)
18 Tear apart half of ribs set before young dog (3,2)
19 I live with 10 wild goats (4)
20 Clipped complaint overheard (4)

Our crosswords are now solvable online
newscientist.com/crosswords

Quick quiz #273
set by Bethan Ackerley

1 Speleology is the study of what?

2 In what year was the first spacewalk performed?

3 Night blindness can be caused by a deficiency of which vitamin?

4 What name is given to the innermost lining of an artery or vein?

5 What do the initials in PCR test, commonly used to detect covid-19, stand for?

Answers on page 47

BrainTwister
set by Christopher Dearlove

#41 There are three prisoners

Three mathematicians are held prisoner and made to play a game in which they each have a blob painted on their forehead in green or blue, with an independent 50 per cent chance of either colour for each prisoner. They must all simultaneously guess their own blob colour or say nothing. They lose the game if nobody guesses or if someone guesses wrong.

How can they plan to play so they guarantee a 50 per cent chance of winning?

How can they increase their chances of winning to 75 per cent?

The prison guards overhear the mathematicians plotting. To thwart the prisoners' strategy, the guards change the rules so they now choose the blob colours. If each prisoner has a fair coin they can flip once, can they use them to come up with a modified strategy with a 75 per cent success rate? The prisoners can see all three coins, but the guards can't see any of them.

Solution next week

Which way?

Compared with a completely still universal reference point, how fast am I moving and in which direction?

Chris Daniel
Glan Conwy, UK
Right now, you are probably stationary relative to your surroundings. But Earth is on its daily rotation about its axis, so, relative to a point in space just above you, you could be travelling east at up to 1670 kilometres per hour, depending on how close you are to the equator. Earth is also orbiting the sun at around 107,000 km/h in an anticlockwise direction as viewed from the North Pole.

Meanwhile, the stars in our neighbourhood of the galaxy are all moving round the Milky Way at slightly different speeds relative to one another: our solar system is currently moving at 70,000 km/h towards the star Vega. But at the same time, we are following an undulating elliptical orbit about 50,000 light years across around the centre of the galaxy at speeds of about 828,000 km/h, each orbit taking around 225 million years. The plane of the solar system is tilted about 60 degrees to the plane of the galaxy.

"Our total speed in the universe is unimaginably fast, but we do know the direction we are heading in"

The Milky Way is also moving through the universe, but it isn't possible to measure its speed against a stationary point because the universe is expanding. However, our speed and direction can be deduced by observing the red and blue shift in the cosmic microwave background radiation, the remnants of the big bang. Our galaxy has been shown to be travelling at 390,000 km/h towards the Andromeda galaxy, our nearest neighbour in the local group of galaxies, which is part of the bigger Virgo Supercluster. Together, we are moving at 2.2 million km/h towards a point called The Great Attractor in the centre of the even larger Laniakea Supercluster.

Our total speed in the universe is unimaginably fast, but we do know the direction we are heading in – at least for the next few billion years.

Eric Kvaalen
Les Essarts-le-Roi, France
There is no such thing as a completely still universal reference point. That idea may have held for most of history, but it has been eroded bit by bit.

At first, people thought Earth was immovable, but some of the ancient Greeks believed it was rotating, and Aristarchus of Samos even proposed that it travelled around the sun. This wasn't accepted until after Nicolaus Copernicus in the early 16th century.

Newtonian physics showed that even the sun moves, jostled by the pull of the planets. In Newtonian physics, there is no notion of "stationary". General relativity maintains that all free-falling objects are equally entitled to be called stationary, and obviously they move, one with respect to another.

You could take the centre of gravity of the Milky Way as a sort of stand-in for a stationary point. With respect to that, we are moving at around 230 kilometres per second in the direction of the star Deneb in Cygnus.

Alternatively, we could use the cosmic microwave background radiation as a standard. In that case, we are moving at around 370 km/s in the direction of the constellation Leo.

David Muir
Edinburgh, UK
Earth rotates on its axis once every 23 hours, 56 minutes and 4 seconds, and its circumference at the equator is around 40,000 kilometres. This means if you are sat on the equator, you are moving at over 1600 km/h due to Earth's rotation. Your speed decreases if you go north or south.

Examples of spin speeds as you go north are: Paris = 1096 km/h; London = 1040 km/h; Edinburgh = 933 km/h; Reykjavik = 732 km/h; Qaanaaq in Greenland = 362 km/h. If you were sat at the North Pole, you would be stationary but rotating once a day. You and your head would be literally spinning, but slowly.

Michael Ham
Matthews, North Carolina, US
Today, I walked a mile in 15 minutes. I'm tired! As I was doing that, Earth turned 420 km on its axis as it moved 2670 km in its journey around the sun and the solar system danced for 16,000 km within our galactic arm and the Milky Way turned 190,000 km around its centre as our galaxy flew 540,000 km through the ether, and always in a counterclockwise direction.

Today, I travelled 749,090 km in 15 minutes! I'm really dizzy and really, really tired.

CLARE/STOCKIMO/ALAMY

This cow's nostrils point straight out – unlike those of humans, which point down

This week's new questions

Being nosy **Why do our nostrils point down while those of most mammals point straight out from their face?** ***Sylvie Yannello****, New York, US*

Blowing up **Could a huge, prolonged volcanic eruption, like those said to have caused several past mass extinctions, happen again?** ***Richard Swifte****, Darmstadt, Germany*

Caught in a trap

My humane mousetrap's instructions tell me to release my visitor a mile away or it may find its way back. Can this be true? (continued)

Greg Eaton
Jamestown, South Australia
Some 20 years ago, we lived in the bush east of Perth in Australia.

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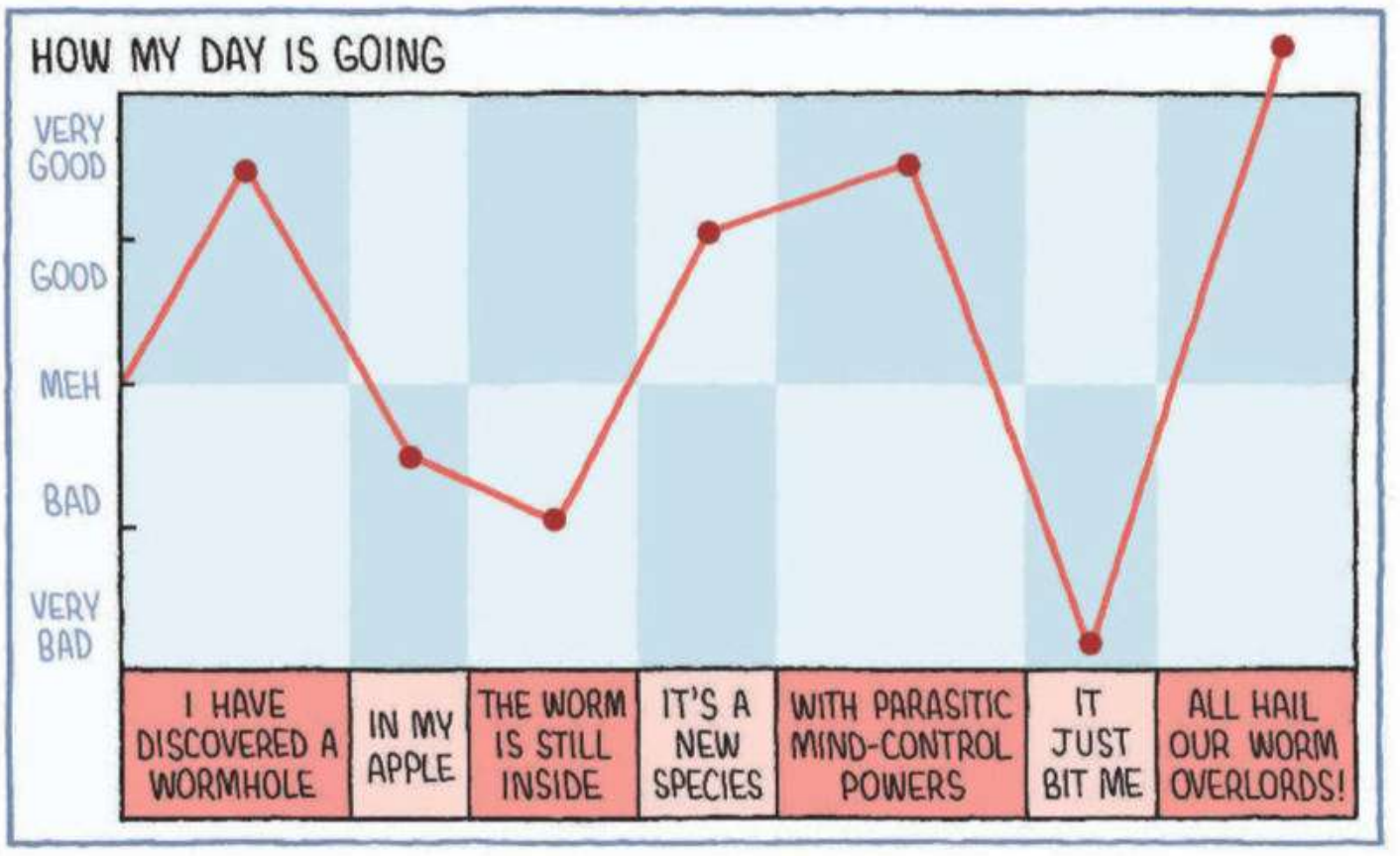
Tom Gauld
for New Scientist



We had a small family of racecourse goanna monitor lizards living on the exposed beams in our lounge. I say small, but they were each well over a metre in length with many distinctive battle scars. They were no problem for us: they kept the insects in order, often diving from the beams to catch moths mid-air.

That was, until my parents came to visit from Queensland. Then the goannas – regularly, on their hind legs while hissing loudly – bailed my mother up in the hallway and threatened her, not allowing her to enter the lounge (which was obviously their domain).

As a dutiful son, I captured them under bath towels and transported them some 3 kilometres down the hills, several roads away from our home (my wife drove while I juggled two large goannas). I did this several times: each time, within two days, they were back lounging along the beams in our obviously shared lounge.

So, to answer your question, maybe mice can find their way back too.

"I captured goannas under towels and transported them 3 km down the road. Within two days, they were back"

Trevor Metterhauser
Reading, Pennsylvania, US
Animals tend to have a "home-range" territory to which they return, or visit regularly. Research has shown this to be true for deer, bears, turkeys, skunks and many other forms of wildlife.

When I purchased my home, there was a skunk problem in the neighbourhood. I proceeded to live trap and release the skunks in the nearby forest. That summer, I trapped a total of 18 (I have never been sprayed and if *New Scientist* is interested in my method, I would be happy to elaborate).

I began to notice some skunks seemed familiar and began to read articles about roaming ranges. After looking at the various research reports, I have nearly eliminated the skunk population in my town by driving the skunks 30 kilometres away and releasing them on my aunt's farm.

Jonathan Sakula
Encombe, Kent, UK
This reminds me of our experiences in Quebec, Canada. Over a five-year period, we caught a groundhog three times in a cage and released it into the wild more than 8 kilometres away. On each occasion, a groundhog reappeared in our garden after a week or so.

We didn't know whether it was the same animal or if another one had adopted the vacant burrow. I wonder if any specialists in groundhog behaviour could clarify this?

Bruce Cumming
Via email
I would refer this enquirer to the ancient truism "always walk a mile in their shoes before you complain about them, because you will be 1 mile away and have their shoes". ▮

Answers

Quick quiz #273 *Answers*

1 Caves
2 1965
3 Vitamin A
4 Tunica intima
5 Polymerase chain reaction

Quick crossword #168 *Answers*

ACROSS 7 Jabiru, **8** Stimulus, **9** Pendulum, **10** Hooves, **11** Vitamin C, **12** Joules, **13** Benzene ring, **18** Revs up, **20** Ultimate, **22** Obtuse, **23** Thirteen, **24** Troisier, **25** Deduct

DOWN 1 Paresis, **2** Mind game, **3** Nuclei, **4** Nightjar, **5** Sudoku, **6** Quieter, **8** Semiconductor, **14** Zeppelin, **15** Nematode, **16** Seaborg, **17** Stretch, **19** SI unit, **21** Thirds

#40 There are four lights *Solution*

There are four ways to get from light D to light A: blue-blue-red, blue-red-blue, red-blue-blue and red-red-blue.

Light B cannot be lit directly after blue is pressed, as no blue arrow points to it.

Pressing blue-red-blue guarantees that either A or D is lit. Pressing blue first ensures that A, C or D is lit. Pressing red then causes D, A or B to be lit, and the final blue doesn't change D or A, but will turn B to A.

Pressing blue-red-blue-red-blue guarantees that A is lit. We know after blue-red-blue that A or D is lit. Pressing red makes that A or B, then the final blue turns B to A or leaves A unchanged.

Cat or dog person?

Leah Michelle Baines and Jessica Lee Oliva at James Cook University in Australia say they have discovered that people who own dogs tend to be more resilient than those who own cats. They also report discovering that people who own cats tend to be more neurotic than those who own dogs.

Writing in *Anthrozoös*, they say: "In contrast to our expectations, no other personality differences were found between pet owners... Findings suggest that personality factors might explain why people who choose to own dogs fare better than people who choose not to own dogs during challenging times of social isolation, which may be unrelated to the animal itself."

Sizing up satisfaction

Much of science depends on the question "how can I measure this thing (whatever this thing is) accurately, precisely and reliably enough to gain insight about it". That question almost screams – maybe in ecstasy, maybe in agony, maybe in puzzlement – from a research paper that reader Nicolas Clairis brought to Feedback's attention.

"Do sex toys make me satisfied? The use of sex toys in Denmark, Norway, Sweden, Finland, France, and the UK" was published by Gert Martin Hald, Silvia Pavan and Camilla S. Øverup in *The Journal of Sex Research*.

How, Feedback has stayed up nights wondering, could one measure that kind of satisfaction in someone other than oneself? Measure it in a way that would make one feel confident that the answer is accurate and true?

Apparently unafraid of the problem, Hald, Pavan and Øverup went at it. They went at it more than a thousandfold. More than 10 times a thousandfold. They sought measurements of a sort from "11,944 respondents from six European countries".

Feedback hesitates to go into detail here about how the team got and interpreted the 11,944 answers. If the temptation is too much for you to resist, go read the paper. Tell us whether you find its climactic conclusion to be satisfying.

Twisteddoodles *for New Scientist*

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Coffee controversy

Nothing gets kidneys pumping quite the way coffee does – and nothing gets the hearts and minds of kidney researchers pumping quite the way the kidneys/coffee question does. *Kidney International Reports* sometimes treats its readers to boluses of opinion and fact about this, from researchers who seem emotionally primed and pumped.

A two-part question drives this action: exactly how, and exactly how much, does coffee get kidneys pumping? A back-and-forth between two groups of US researchers began with the publication of "Coffee consumption may mitigate the risk for acute kidney injury". Its authors say that "higher coffee intake was associated with a lower risk" of kidney problems.

The team looked at data collected during a three-year span, in which 15,792 middle-aged people indicated how many cups of coffee they thought they had swallowed during the previous year – thus, 15,792 self-educated guesses. The study compares those guessed coffee-cup tallies with each person's record, in later life, of what it calls "acute kidney injury events", or AKIs.

A second group responded by pumping out a letter called "The missing link between coffee consumption and AKI-water". The drinks, or the failure to drink, can have overwhelming effects on the kidneys, the researchers suggest. They also suggest that the first group may not have fully considered that.

The first group disagreed, and pumped back a well-maybe-but-Killer response, citing a study about coffee and dehydration. That British study's lead author: Sophie Killer.

Onward forth, and onward back, sloshes the discussion. More recently, a third group based in China, South Korea and the Czech Republic brought the flow of opinion again into its traditional middle-ground muddle. "In summary," says the team's report, "several contradictory effects of caffeine intake on kidney function have been reported".

Coffee to prevent covid-19

Coffee-drinking can have almost any desired medical effect on a person, to some degree. In some cases, that degree is zero. In other cases, it's not.

Chen-Shiou Wu at China Medical University in Taiwan and colleagues ran experiments that led them to publish a study called "Coffee as a dietary strategy to prevent SARS-CoV-2 infection".

Their first experiment asked if coffee could impede the SARS-CoV-2 virus from infecting human embryonic kidney cells nurtured in a lab. Then they drew and did experiments on blood from 64 coffee drinkers. The cell work and the drinker work, combined, led to some optimistic suggestions.

The team reports that the ideal timeline for coffee to inhibit SARS-CoV-2 infection is within 6 hours. "Taken together," they say, "drinking 1–2 cups of coffee [or even] decaffeinated coffee daily can potently reduce SARS-CoV-2 infection including wild-type, Alpha, Delta, and Omicron variants." These likelihoods "can serve as a guideline for dietary health during coexistence with SARS-CoV-2".

At most, this could be the effective, simple treatment that everyone has been seeking. At least, coffee is as efficacious against covid-19 as it is against most other diseases. ▮

Marc Abrahams

‘Brightling’

Despite its 10.95mm height, the Trident C60 Pro 300 ‘Lumiére’ leaps from your wrist. (Just like it jumped off this page.) Its brightness results from proudly protruding indices and the logo they encircle. Featuring facets finely machined to tolerances of 0.03mm, these mini-monoliths are super-legible in daylight. But it’s the Globolight®, the unique luminous ceramic from which they’re hewn, that produces their astounding, super-brilliance at night. And inspired this timepiece’s name. The light show doesn’t end there. Carved from titanium, the 41mm case incorporates a second sapphire crystal displaying its super-accurate movement. But it’s not the back of this beautiful tool watch you’re buying into. Is it?

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